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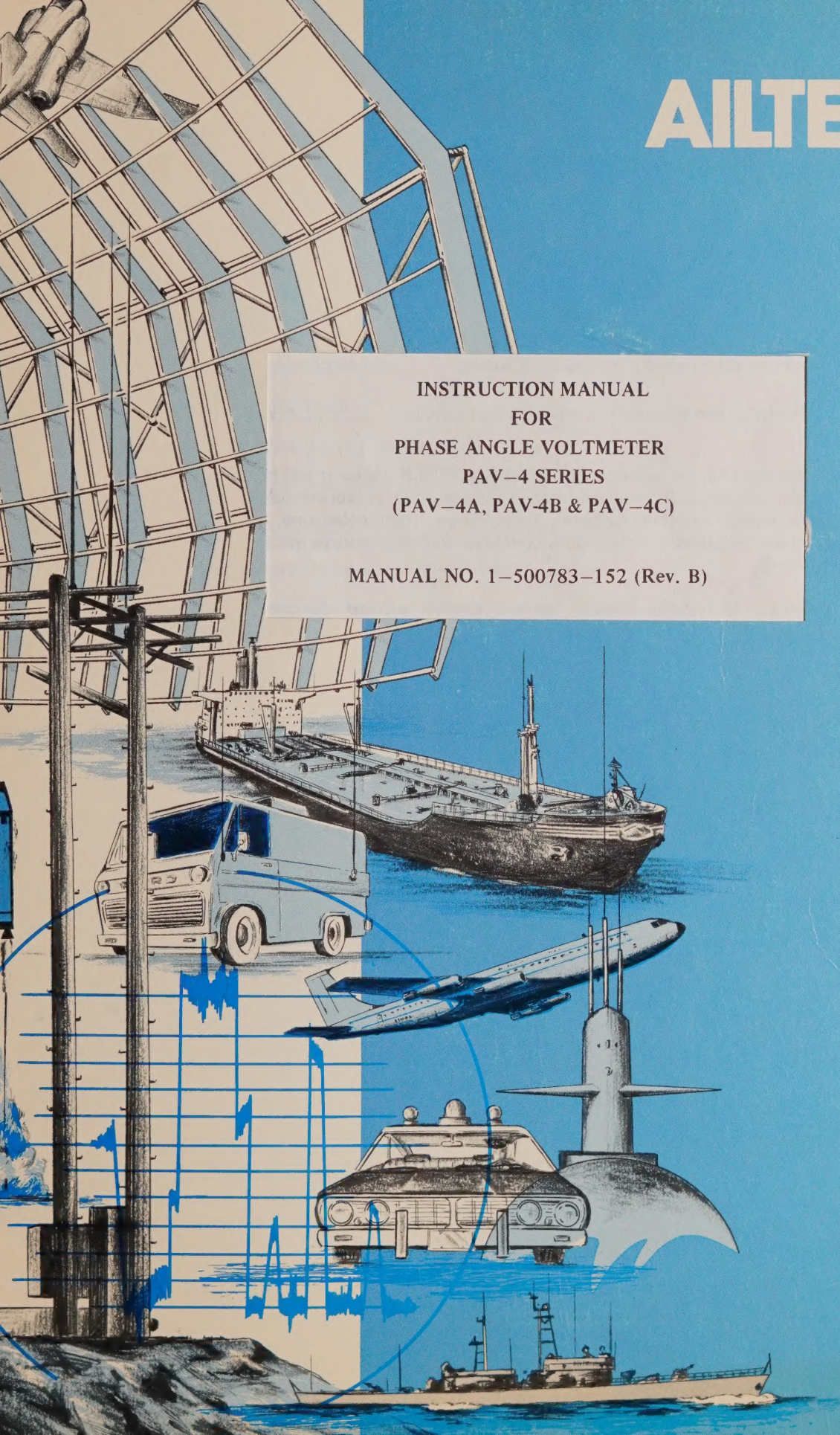

INSTRUCTION MANUAL
FOR
PHASE ANGLE VOLTMETER
PAV–4 SERIES
(PAV–4A, PAV-4B & PAV–4C)

MANUAL NO. 1–500783–152 (Rev. B)

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Addendums 1 and 2

Eaton Corporation
Electronic Instrumentation Division
Los Angeles Plant
5340 Alla Road
Los Angeles, California 90066

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Eaton Corporation, Electronic Instrumentation Division, Los Angeles Plant, (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

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Repair or replacement (at our option) without charge (F.O.B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and Ratio Tran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

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With respect to repairs, the foregoing warranty shall apply for a period of ninety days to the repaired portion.

Eaton Corporation,
Electronic Instrumentation Division, Los Angeles Plant
5340 Alla Road, Los Angeles, California 90066

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the Representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory Prepaid. Validity of warranty will be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Maintenance action previously requested or performed.
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

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FOREWORD

This instruction manual provides operation and maintenance data for the Gertsch Model PAV-4 Series Phase Angle Voltmeters. Sections I through VI cover the basic units, PAV-4A, PAV-4B and PAV-4C. Sections VII and subsequent provide data on the various plug-in modules used with the basic unit. Mainframes with serial numbers 400 and below have slight differences from S/N 401 and up. Separate schematics are provided for these units and parts list differences are noted.

The information refers to the standard model listed above and is current only to the date of publication. Differences resulting from the Singer Company's continuous product improvement program are described in addendum sheets. Additional models reflecting customer design and application requirements are described in difference data sheets.

In some cases, part values, ratings and manufacture source are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

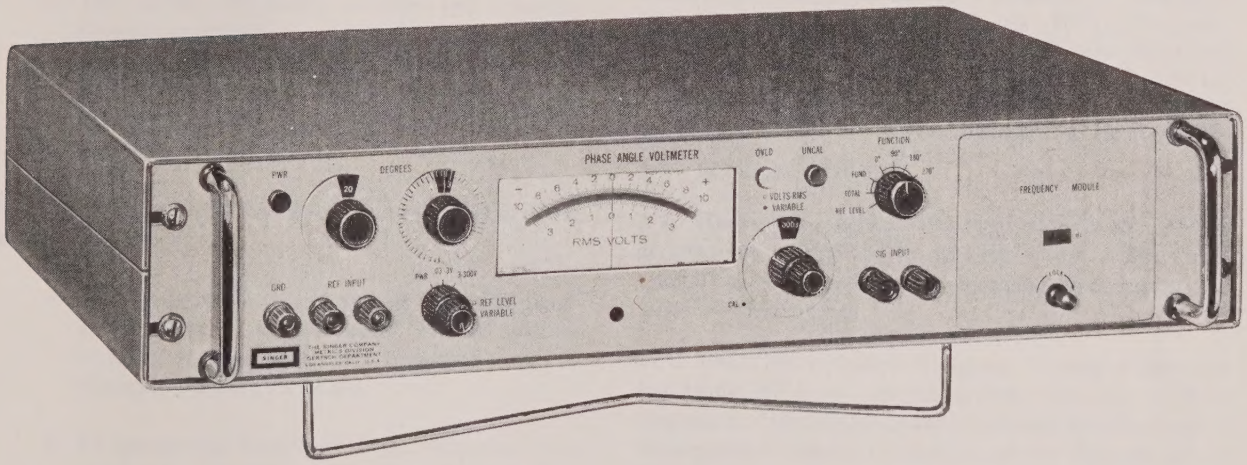

Figure 1-1. Model PAV-4 Phase Angle Voltmeter

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SECTION I
GENERAL DESCRIPTION

1-1. PURPOSE

1-2. Model PAV-4 Phase Angle Voltmeter combines the capabilities of a standard voltmeter and a phase sensitive voltmeter into a single unit.

a. In combination with Gertsch synchro and resolver test equipment, the Model PAV provides complete checkout capabilities for AC rotating components.

b. In transfer function and filter analysis, the Model PAV provides gain and phase shift readouts on a single panel. Through the use of a variable range control, gain may be displayed as a direct percentage readout.

c. The variable frequency modules use a unique heterodyne system in which the Model PAV is phase locked to an incoming signal. This capability allows the Model PAV-4 to be used for any application which requires pin-point analysis at a unique frequency.

1-3. As a voltmeter, the Model PAV may be used in either of two ways:

a. To measure the total rms voltage of any AC signal in the 30Hz to 300KHz range. With an isolated input (Model PAV-4B), the frequency range is limited to 300Hz to 300KHz.

b. To measure the fundamental rms component of a signal at a selected frequency. In this application, band pass filtering is provided.

1-4. As a phase angle voltmeter, the instrument may be used for a variety of tests in three basic ways:

a. To measure the phase angle between a signal and reference voltage (phase shift through a test piece or system). The Model PAV may be used to measure amplitude at this phase shift angle.

b. To measure the in-phase and quadrature components of the input signal.

c. As a phase sensitive null indicator for extremely accurate bridging circuits. A high tolerance to a quadrature component allows null measurements under a wide variety of conditions. This tolerance is expressed as overload ratio; as noted in the specifications, the quadrature input may be ten times the full scale voltage of the selected range without disturbing the null measurement.

1-5. Front panel controls provide fast changes in mode of operation. In-phase, quadrature, fundamental, and total voltage comparisons may be made without changing the test set-up. The PAV may be switched from use as a sensitive null indicator to measuring absolute voltage magnitude, again without changing a test set-up.

1-6. MODEL DIFFERENCES.

1-7. Model PAV-4A features direct signal and reference inputs with maximum accuracy and the broadest frequency range in the total mode. Model PAV-4B features isolated inputs for measuring differential signals. With either mode, the input impedance is 10 megohms, 25pf, thus minimizing loading effects on a unit under test. (Add 45pf for rear terminals.) Model PAV-4C is identical to Model PAV-4B with the exception that the frequency range is 57Hz to 20KHz.

1-8. PLUG-IN MODULES.

1-9. Model SF-1 Single Frequency Module (± 5%) provides an economical approach to production line testing. This module can be supplied with any single frequency in the 30Hz to 10KHz range.

1-10. Model MF-1 Multiple Frequency Module is similar to the Model SF-1 but can be supplied with up to three frequencies. Operating frequency is selected by a front-panel, three-position switch. Frequency can be changed in the field by changing plug-in components in the module.

1-11. Model VF-1 Variable Frequency Module provides continuous coverage from 300Hz to 10KHz. A unique phase lock circuit eliminates precise tuning; a single tuning control is adjusted until a front panel light indicates phase lock. Remote tuning may also be used with this module.

1-12. Model VF-2 Variable Frequency Module provides continuous coverage from 10KHz to 300KHz. This module is similar to the Model VF-1.

1-13. DESCRIPTION

1-14. The Model PAV is a self-contained test instrument which only requires connection to a 115/230 vac power source. Power conversion is accomplished by selecting a switch setting and changing a fuse value.

TABLE 1-1. SPECIFICATIONS

Voltage Range:	300 μ vrms to 300 vrms in 13 ranges		
Range Vernier:	100% to 30% without affecting overload ratio		
Phase Range:	–10 to 360 deg., 0.1 resolution		
Frequency Range			
Total Mode, PAV-4A:	30Hz to 300KHz		
Total Mode, PAV-4B:	300Hz to 300KHz		
Total Mode, PAV-4C:	57Hz to 20KHz		
Filtered Mode:	See Plug-in Specifications		
Accuracy			
Voltage, Total Mode	2% (50Hz to 20KHz) of f.s. 3% (30Hz to 100KHz) of f.s. 5% (100KHz to 300KHz) of f.s.		
Voltage, Filtered Modes:	2% of f.s.		
Temperature Coefficient:	±0.1%/°C from 25°C		
Input Impedance			
Signal:	10M, 25pf (nom. w/o rear term)*		
Reference:	10M, 25pf (nom. w/o rear term)*		
Input Common to Case Grd, PAV-4B/PAV-4C:	200pf (max w/o rear term)*		
Reference Input Voltage:	0.03V to 300 vrms		
Overload Ratio:	10x Full Scale		
Noise:	PAV-4A	PAV-4B/PAV-4C	
Total Mode:	20 μV (max)	30 μV (max)	
Fund. Mode:	10 μV (max)	15 μV (max)	
Nulling Sensitivity	2 μV	2 μV	
Harmonic Rejection:	See Plug-in Specifications		

Temperature Range:	0 to 50 degrees C
Recorder Output:	±1 VDC or.3 VDC, 1 MADC equals f.s. single-ended
AC Amplifier Output:	200MVRMS (approx.) equals f.s. single-ended
Power:	115/230V ±10%, 50-400Hz
Size:	3½" H x 19" W x 14" D
MODEL SF-1, MF-1:	Plug-in Modules
Frequency Range:	30Hz to 10KHz
Bandwidth:	±5%
Phase Accuracy:	0.5 deg. over entire freq. range
Phase T/C:	0.01 degrees/degree C
Harmonic Rejection:	
Fund. Mode:	45 db (3rd harmonic and above)
PAV Mode:	55 db
Δf_o Ripple Signal Filter:	±0.6% from value of f_o (above 50Hz)
Phase Tracking over pass band at 25°C:	±0.2 degrees (above 50Hz) ±0.5 degrees (below 50Hz)
MODEL VF-1, VF-2:	Plug-in Modules
Frequency Range:	300Hz to 10KHz (VF-1) 10KHz to 300KHz (VF-2)
Bandwidth:	Phase-locked to input reference
Phase Accuracy:	(1.0 + 0.01f KHz) degrees
Phase T/C:	0.03 degrees/degree C
Harmonic Rejection:	2nd > 40 db 3rd > 55 db

*Add 45pf for rear terminals.

1-15. All operating controls, indicators, and connectors are mounted on the front panel. Back panel connections include the following:

a. A DC voltage or current output for driving a recorder or an external "go," "no-go" control system.

b. An AC amplifier output.

NOTE

The amplitude of both the above outputs is directly related to the voltage indication.

c. The remote tuning input for the variable frequency modules.

SECTION II

INSTALLATION

2-1. UNPACKING

2-2. No special handling or unpacking procedures are required. After unpacking, inspect unit for any evidence of damage.

2-3. MOUNTING

2-4. The unit is designed for standard 19" rack mounting however, mounting is not required and the unit may be used as a portable unit.

2-5. ELECTRICAL CONNECTIONS

2-6. Determine voltage of power source (115 or 230vac). Set slide switch A5S1 (located on the Power supply and regulator board) to appropriate position and select fuse F1 for power source (115 vac use 1/2 amp fuse, 230 vac use 1/4 amp fuse). The unit is set for 115 vac power when shipped from the factory, unless otherwise indicated.

SECTION III

OPERATING INSTRUCTIONS

3-1. PHASE ANGLE MEASUREMENT

a. Check mechanical zero of meter. Reset if required.

b. Connect reference input voltage to REF INPUT binding posts.

c. Connect signal input (output of device under test) to SIG INPUT binding posts.

d. Turn REF LEVEL switch cw from PWR position. The PWR indicator should light.

e. Set FUNCTION switch to the REF LEVEL position.

f. Adjust REF LEVEL and associated VARIABLE control as required to obtain a meter deflection to the REF LEVEL mark.

g. Set FUNCTION switch and DEGREES controls to 0 degree.

h. (1) If multiple frequency module is used, set FREQUENCY switch to the required frequency.

(2) If variable frequency module is used, adjust frequency control until lock indicator is lit. Approach from high frequency end.

i. Adjust FUNCTION switch and DEGREES controls to obtain a maximum indication to the right on the meter. First set FUNCTION switch to the 0 degree position and then adjust DEGREES switch through its entire range. If the meter does not indicate a positive (to the right) peak deflection, turn FUNCTION switch to the 90 degree position and repeat adjustment of DEGREES switch. Adjust VOLTS-RMS (range) switch as required.

j. Turn FUNCTION switch 90 degrees in either direction from the position at which maximum positive meter deflection was obtained.

k. Adjust DEGREES controls to obtain an exact null on the meter. For more sensitive null indications, the VOLTS-RMS (range) switch may be turned to lower ranges until the OVLD lamp lights. When the light does light, use the next higher range. When an exact null is obtained, return the VOLTS-RMS range selector to original position.

l. With FUNCTION switch in the position (0, 90, 180, 270 degrees) which gives a meter deflection to the right (+), the phase angle between the signal and input reference voltages is equal to the angular position of the FUNCTION selector plus the dial indications of the 10 and 1 DEGREES controls. The total amplitude of the vector is indicated by the meter (if the VARIABLE range control is in the CAL position).

3-2. IN-PHASE AND QUADRATURE COMPONENT MEASUREMENTS.

a. Adjust instrument as outlined in steps a through h of paragraph 3-1.

b. Set VARIABLE control associated with VOLTS-RMS switch to the CAL position. Make certain the UNCAL indicator is not lit.

c. To measure the in-phase component, turn the FUNCTION switch and DEGREES controls to the 0 degree position. The meter will then indicate the amplitude of the in-phase component.

d. To measure the quadrature component, turn FUNCTION switch to the 90 degree position and DEGREES controls to the 0 degree position. The meter will then indicate the amplitude of the quadrature component.

NOTE

For more accurate measurement, the VOLTS-RMS (range) switch may be turned to lower ranges until the OVLD light lights. If the light does light, use the next higher range.

3-3. VARIABLE CONTROL USE. If a full scale meter reading, other than those available through use of the VOLTS-RMS (range) switch is desired, adjust the VARIABLE control as follows:

a. Apply a signal with the required full scale amplitude to SIGNAL binding posts.

b. Turn FUNCTION switch to the desired position.

c. Starting with the highest range, turn VOLTS-RMS (range) switch to the first position which casues an off-scale meter indication.

d. Adjust VARIABLE range control until the meter indicates full scale deflection. The UNCAL light will light when the VARIABLE range control is turned from the CAL position.

3-4. NULL INDICATOR USE. To use the instrument as a phase sensitive null indicator, proceed as follows:

a. Adjust instrument as outlined in steps a through h of paragraph 3-1.

b. Determine the phase angle of the axis along which a null is desired. This angle will be determined by the application.

c. Set the sum of the FUNCTION selector and the DEGREES dials to equal the angle in step a above.

d. Adjust the unit under test (or external test equipment) until the meter indicates zero voltage (null).

e. To measure the quadrature voltage at null, turn FUNCTION switch 90 degrees from its initial setting in either direction.

NOTE

If an "error" signal is in-phase with the reference angle selected the deflection will be + and - if it is out-of-phase.

3-5. TOTAL VTVM OPERATION. To measure the total rms voltage of an incoming signal, proceed as follows:

a. Check mechanical zero of meter. Reset if required.

b. Turn REF LEVEL switch clockwise from the PWR position. The PWR indicator should light.

c. Make certain that VARIABLE range control is in the CAL position.

d. Connect input signal to SIG INPUT binding posts.

e. Turn FUNCTION switch to TOTAL position.

f. Turn VOLTS-RMS (range) switch to the lowest range which provides an on-scale reading.

3-6. FUNDAMENTAL VTVM OPERATION. To measure the fundamental rms component of an incoming signal (less noise and harmonics), proceed as follows:

a. Check mechanical zero of meter. Reset if required.

b. Turn REF LEVEL switch clockwise from the PWR position. The PWR indicator should light.

c. Make certain that the VARIABLE range control is in the CAL position.

d. Connect input signal to SIGNAL binding posts.

e. If variable frequency module is used, adjust instrument as outlined in step a through h of paragraph 3-1.

f. If multiple frequency module is used, turn FREQUENCY switch to the selected frequency.

g. Turn FUNCTION switch to FUND position.

h. Turn VOLTS-RMS (range) switch to the lowest range which provides an on-scale reading.

3-7. EXTERNAL CONNECTIONS.

3-8. VDC OUTPUT. To drive a recording device with a DC voltage, connect recorder between 1VDC (pin 4) and GRD (pin 3) terminals of the back panel terminal board. This output may be adjusted with the VARIABLE control (paragraph 3-3).

3-9. DC CURRENT OUTPUT. To drive a recording device or an external relay with DC current, remove jumber and connect device between 1MADC (pin 2) and GRD (pin 1) terminals of the back panel terminal board. This output may be adjusted with the VARIABLE control (paragraph 3-3). Replace jumber when device is disconnected.

3-10. VAC OUTPUT. To use the AC voltage output, connect device between AC out (pin 5) and GRD (pin 6) terminals of the back panel terminal board. This output may be adjusted with the VARIABLE control (paragraph 3-3).

3-11. EXTERNAL TUNING. To provide external tuning of the variable frequency, disconnect jumper between terminals 7 and 8 of the back panel terminal board. Connect a DC voltage source between EXT IN and GRD. For complete coverage the source should be continuously variable between approximately -7 to +3vdc. Adjust the voltage source instead of the front panel frequency control until approximately +12V appears on terminal 9, or the front panel lock indicator is lit. The voltage source will take the place of the frequency control. Replace jumper when voltage source is removed.

TABLE 3-1. CONTROLS AND INDICATORS

PANEL MARKING	TYPE OF CONTROL (see figure 6-1)	FUNCTION
PWR	Indicator Light (DS)	ON-OFF power indicator.
DEGREES: 10^{O} Steps 1 degree Markings (0.2^{O} inc.)	Switch (S4) Potentiometer (R28)	Calibrated phase shifter. Adjusts the phase angle of the reference voltage as required to equal any phase angle wtihin the set quadrant. The readings of these two dials plus the angular setting of the FUNCTION switch indicates the total phase angle FUNCTION = 90 degrees + DEGREES switch = 20 degrees + DEGREES potentiometer = 7 degrees Total phase angle = 117 degrees
RMS Volts	Meter (M1)	Zero center meter indicates rms voltage or nulls.
OVLD	Indicator light (DS2)	Lights to indicate that the total input signal voltage exceeds the selected range by a factor of 10.
UNCAL	Indicator light (DS3)	Lights to indicate that the VARIABLE range control has been rotated from the CALIBRATED position. Under these conditions, the meter does not indicate full scale voltages equal to the VOLTS-RMS switch settings.
FUNCTION	Rotary Switch (S3)	REF LEVEL – switches circuitry to meter and adjust reference input level.
		TOTAL – switches circuitry to measure total rms value of the input signal.
		FUND – switches circuitry to measure fundamental rms component of the signal.
		0, 90, 180, 270 Degrees – calibrated phase shifter used in conjunction with DEGREES contols. Adjusts phase angle of reference voltage for phase sensitive measurements.
SIG INPUT	Binding Posts (Red – HI) (J2) (Black – LO) (J3)	Input signal connection point.
VOLTS-RMS	Rotary Switch (S1)	13 position range control selects full-scale voltage range of instrument.
VARIABLE	Potentiometer (R5)	Adjustable attenuator provides a variable meter scale factor (an arbitrary input signal may be set for a full-scale meter indication, with the meter scale then used for direct percentage readouts).
REF LEVEL VARIABLE	Rotary Switch (S5) Potentiometer (R2-R3)	Adjusts reference channel to the amplitude level of the reference input. Also functions as power on-off control.
REF INPUT	Binding Posts (Red – HI) (J4) (Black – LO) (J5)	Reference input connection point.

TABLE 3-1. CONTROLS AND INDICATORS (CONT)

PANEL MARKING	TYPE OF CONTROL (see figure 6-1)	FUNCTION
GRD	Binding Post (J6)	Instrument case ground.
NOTE: The following connections are located on the back panel.		
1 MADC	Terminal Board (TB1)	Current output, analog of meter reading.
1 VDC		DC voltage output, 1 VDC for full scale.
DC Out		DC voltage output, analog of meter reading. i.e. 1V on 10's scales, .3V on 3 scales.
AC Out		AC voltage output, analog of input voltage.
VCO EXT In		Provides external tuning of the variable frequency modules.
LOCK IND.		Provides +12-14 VDC Out when VF-1/2 is locked.
SIGNAL INPUT (rear)	Binding Posts (Red – HI) (J8) (Black – LO) (J9)	Input signal connection point. These binding posts are not connected when low capacity input is desired.
REFERENCE INPUT (rear)	Binding Posts (Red – HI) (J10) (Black – LO) (J9)	Input reference voltage connection point. These binding posts are not connected when low capacity input is desired.
115/230V 50 - 400 Hz	Power cable (P1)	Power input.
SINGLE FREQUENCY MODULE		
None		
MULTIPLE FREQUENCY MODULE		
Frequency	3-position rotary switch.	Select frequency for fundamental, or phase sensitive modes of operation.
VARIABLE FREQUENCY MODULE		
Frequency Dial	Potentiometer	Tunes module to operating frequency (fundamental and phase sensitive modes).
LOCK	Indicator Light	Lights to indicate that module is tuned to frequency.

3-12. NOTES ON OPERATION.

3-13. GROUND LOOPS. Ground loops should be avoided particularly when the unit is used as a phase sensitive voltmeter. To avoid ground loops (with PAV-4A), use isolation transformers (Gertsch Model ST103 and ST102 respectively, or equivalent) in the signal and reference input circuits.

3-14. BEAT NOTES. If the power and reference voltage have approximately the same frequency, the two sources should be phase locked if the beat is objectionable to the operator. The most accurate reading is obtained by "averaging" the beat.

3-15. DETECTOR CIRCUIT. The TVM detector circuit is an average responding circuit, calibrated to indicate rms value. When a square wave is applied (or a pulsating DC signal), the average-to-rms values change and therefore a correction factor must be applied to the meter reading:

a. In the total mode, the meter reading is 1.11 times the peak value of the square wave input. A 100V peak-to-peak square wave will read 111 vrms.

b. In the fundamental mode, the meter reading is 0.9 times the peak value of the square wave input. A 100V peak-to-peak square wave will read 90 vrms.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL THEORY

4-2. The signal circuitry, shown in the top section of the block diagram (figure 4-1) provides the range control circuitry and amplification for the signal input. The reference circuitry, shown in the bottom section of the block diagram, converts the reference input signal to the proper reference signal for the phase sensitive detector.

4-3. STANDARD VOLTMETER. When the instrument is used as a standard voltmeter, the reference circuitry is switched out and a full-wave rectifier is used as the meter detector. In the total function, the signal circuit is broad band and therefore the total incoming signal is applied to the meter circuit. The meter circuit is an average measuring circuit but the meter is calibrated to indicate rms value. In the fundamental function, band pass filtering is switched into the signal circuit to minimize noise and harmonics. Under these conditions, the meter indicates the fundamental rms value of the incoming signal.

4-4. PHASE ANGLE VOLTMETER. When the instrument is used as a phase angle voltmeter, a phase sensitive bridge circuit is used as the meter detector. The reference circuit is switched into the system and supplies a reference signal with an adjustable phase angle to the bridge. The input and reference signals are compared in the phase sensitive bridge. When the phase angle of the detector reference signal is adjusted to exactly equal the phase angle of the input signal, the detector output is maximum. Since a filter is switched into the signal channel, the meter indicates the fundamental rms value of the signal input.

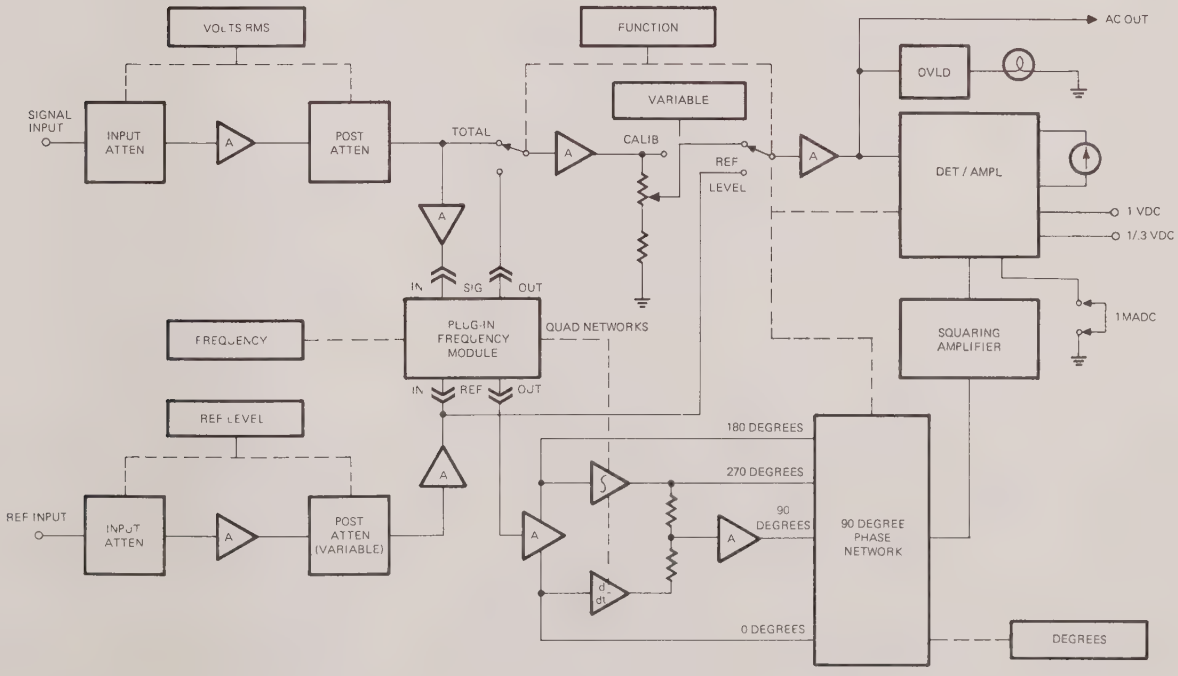


Figure 4-1. Block Diagram

4-5. If there is a phase shift through a unit under test, the output signal as related to the input signal contains two components: an in-phase component (X) and a quadrature component (jY). As shown in Figure 4-2, the phase angle is determined by the relative amplitudes of the components and by the arithmetical signs (plus or minus). At 45 degrees, the amplitudes are equal and both components have a plus sign. At 225 degrees, again the amplitudes are equal, but both components have a minus sign;

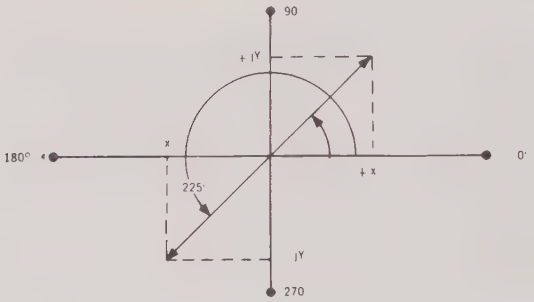


Figure 4-2. Input to Output Signal Relationships

4-6. The reference circuitry uses the reference input signal to generate the detector reference signal. The in-phase portion (X) is obtained by using the reference signal without change. The quadrature portion is obtained by shifting the phase of the reference voltage 90 degrees in a quadrature generator. The two components are combined in the phase angle network.

4-7. PHASE ANGLE NETWORK. A specific phase angle is selected by three controls: the function switch, the 10^{o} DEGREES switch, and the interpolating potentiometer as shown in Figure 4-3. The function switch operates as the quadrant selector and places the proper in-phase and quadrature voltages across the 10 degree resistor network.

4-8. The degrees switch S4 positions the interpolating potentiometer within a resistor network. The network has an in-phase component applied to one end and a quadrature component applied to the other. At the midpoint of the network, the two components are equal. If both components have a plus sign, the midpoint equals a phase angle of 45 degrees. The resistance of the potentiometer provides a 10 degree span and may be placed within the network to provide coverage over any 10 degree span within the 90 degree quadrant.

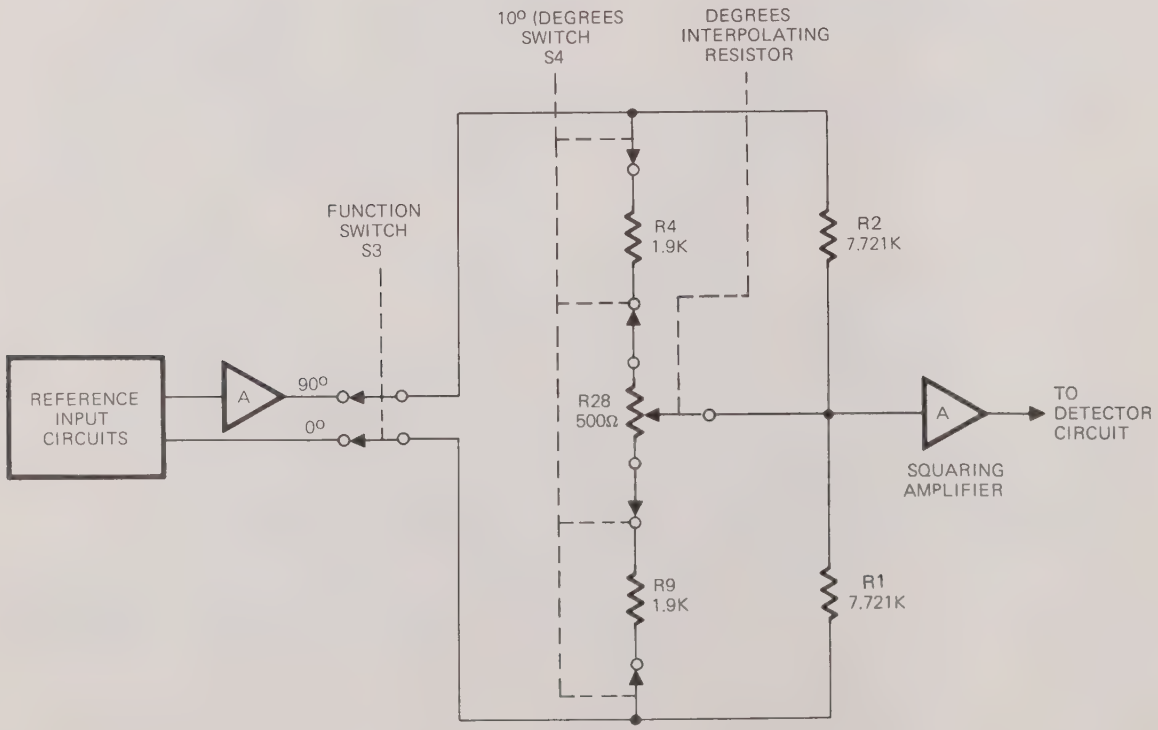


Figure 4-3. Phase Angle Network

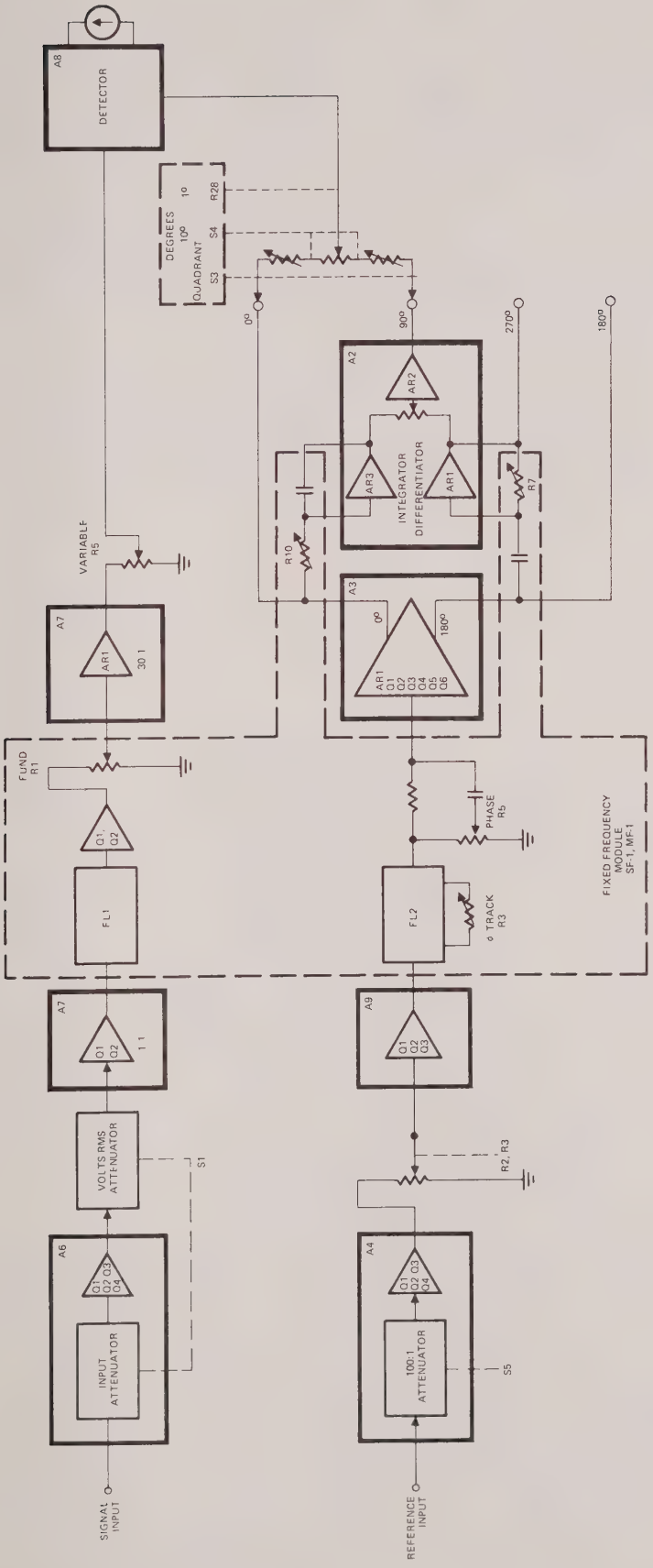


Figure 4-4. Fixed Frequency Modules

4-9. FREQUENCY MODULES.

4-10. SINGLE FREQUENCY MODULE. This module provides a bandpass filter for the signal channel, a bandpass filter for the reference channel, and tuning components for the quadrature generators. These components provide fixed-frequency operation (see figure 4-4).

4-11. The components for the signal channel consist of a bandpass filter FL1, an emitter follower Q1, Q2, and a variable resistor R1 (FUND). This resistor compensates for variations in the insertion losses of the filters.

4-12. The components for the reference channel consist of a bandpass filter FL2 and the RC components for the two 90 degree generators. Phase resistor R5 compensates for minor phase shifts through the reference channel. Track resistor R3 adjusts the bandpass characteristics of the filter. Resistor R10 adjusts the integrating amplifier and resistor R7 adjusts the differentiating amplifier.

4-13. MULTIPLE FREQUENCY MODULE. This module is similar to the single frequency module except that three sets of components are included.

4-14. VARIABLE FREQUENCY MODULE. This input signal and reference voltages are mixed with outputs of an oscillator to provide IF frequencies (see figure 4-5). The IF frequencies are then filtered and delivered to the PAV circuits.

4-15. The mixer frequency is provided by a DC voltage controlled oscillator. This oscillator is tuned by a variable potentiometer (frequency control) and the output of a phase detector. A highly stable, IF oscillator provides a comparison frequency for the phase detector. A second phase detector provides an output for the lock light.

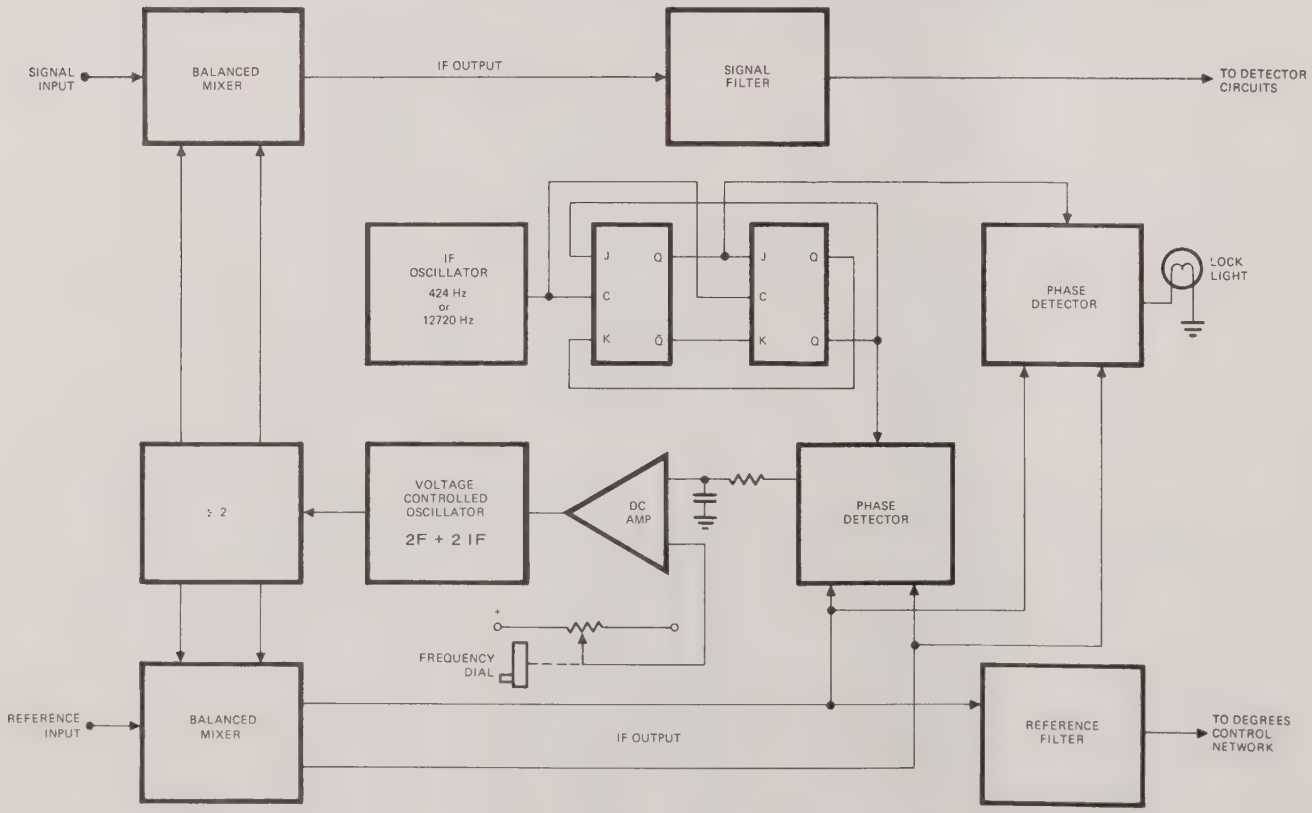
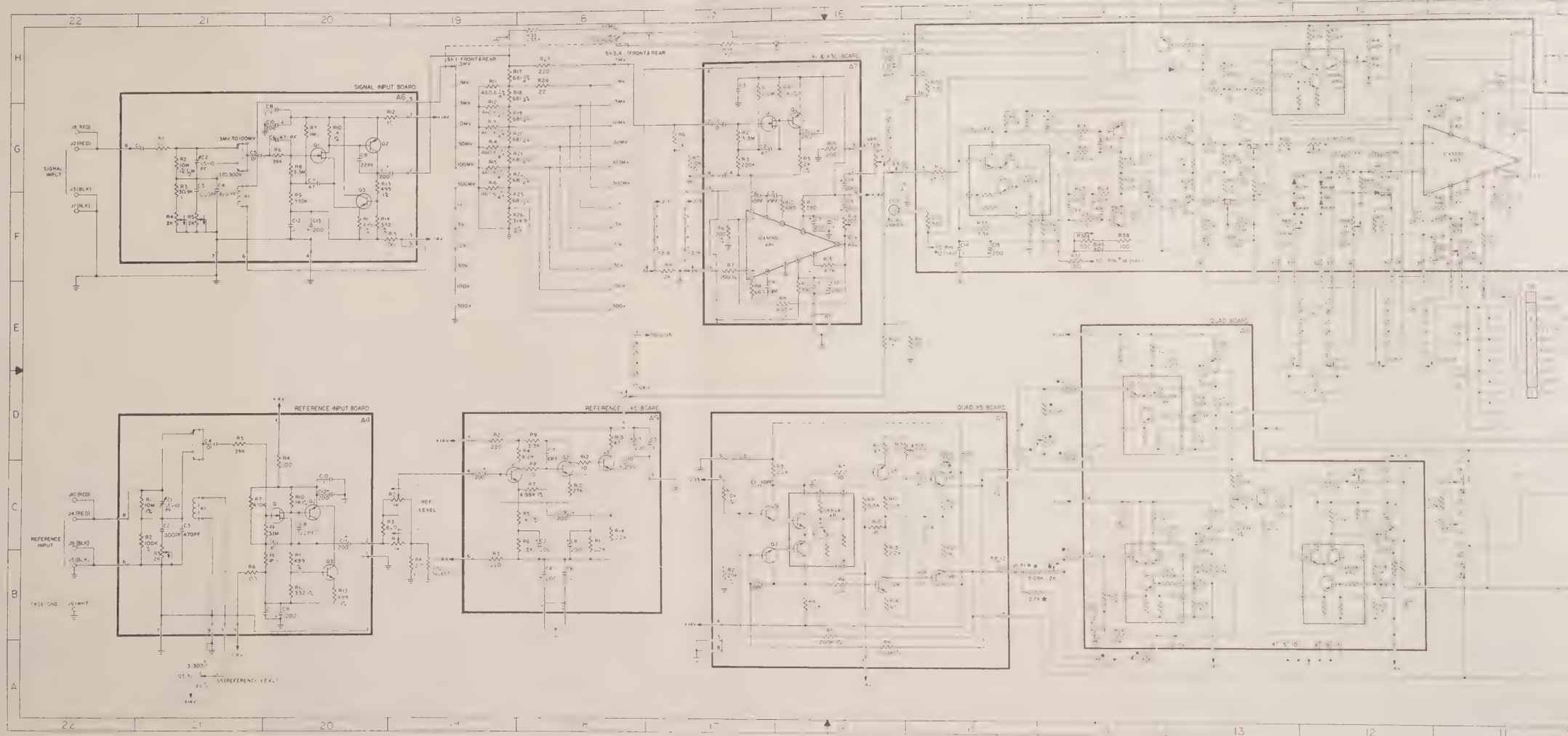
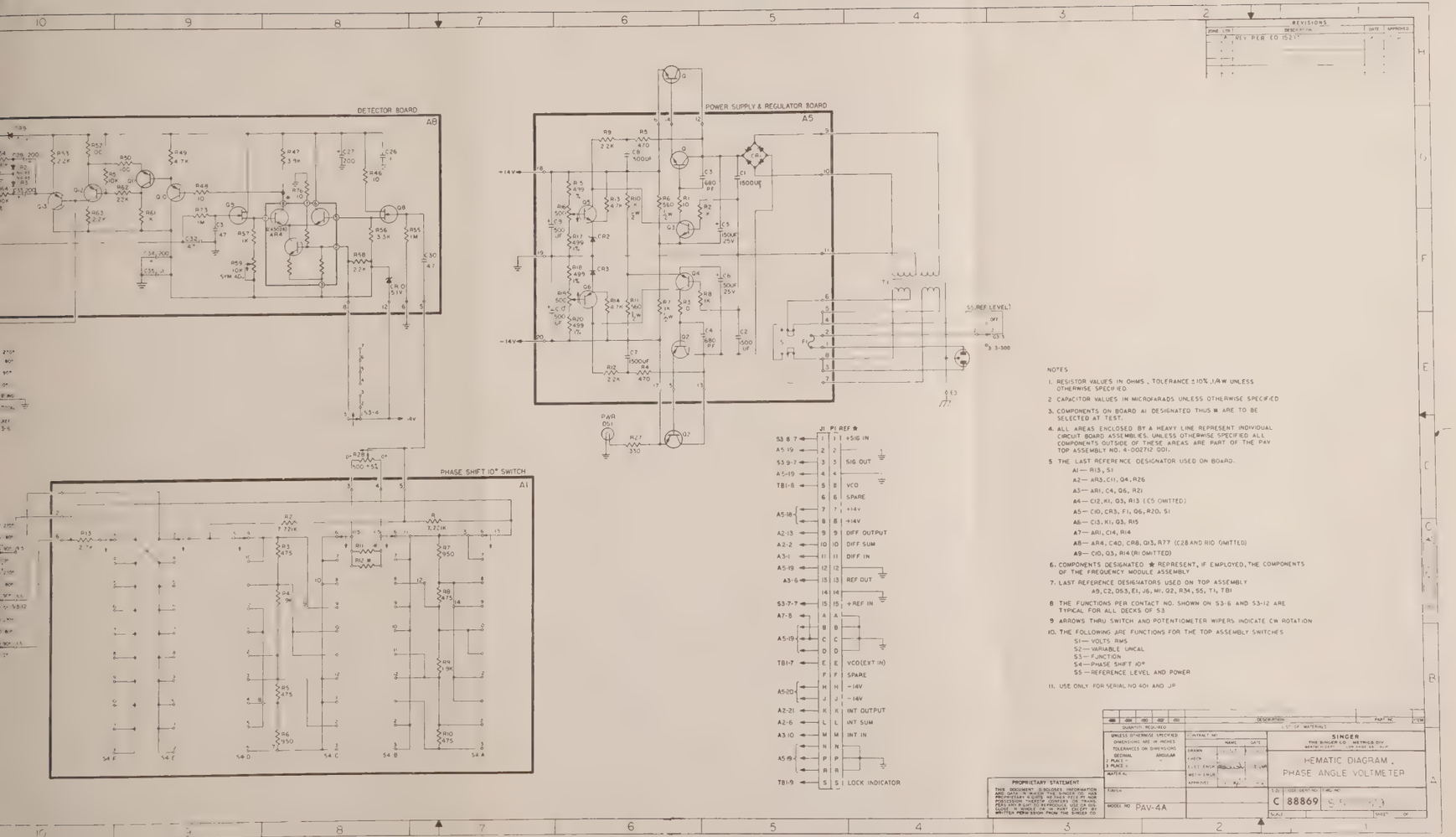


Figure 4-5. Variable Frequency Module


SIGNAL INPUT BOARD
A6
SIGNAL INPUT
REFERENCE INPUT BOARD
A4
REFERENCE INPUT
REFERENCE X5 BOARD
A5
REF LEVEL
X1 & X10 BOARD
A7
QUAD BOARD
QUAD X5 BOARD
A2
SS(REFERENCE LEVEL)
3MV TO 100MV
1MV FRONT & REAR
3MV FRONT & REAR
22
21
20
19
18
17
16
15
14
13
12
11
H
G
F
E
D
C
B
A



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REV PER EO 1521		

NOTES

1. RESISTOR VALUES IN OHMS, TOLERANCE ±10%, 1/4W UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED
3. COMPONENTS ON BOARD A1 DESIGNATED THUS ✱ ARE TO BE SELECTED AT TEST.
4. ALL AREAS ENCLOSED BY A HEAVY LINE REPRESENT INDIVIDUAL CIRCUIT BOARD ASSEMBLIES. UNLESS OTHERWISE SPECIFIED ALL COMPONENTS OUTSIDE OF THESE AREAS ARE PART OF THE PAV TOP ASSEMBLY NO. 4-002712 001.
5. THE LAST REFERENCE DESIGNATOR USED ON BOARD.
   - A1 — R13, S1
   - A2 — AR3, C11, Q4, R26
   - A3 — AR1, C4, Q6, R21
   - A4 — C12, K1, Q3, R13 (C5 OMITTED)
   - A5 — C10, CR3, F1, Q6, R20, S1
   - A6 — C13, K1, Q3, R15
   - A7 — AR1, C14, R14
   - A8 — AR4, C40, CR8, Q13, R77 (C28 AND R10 OMITTED)
   - A9 — C10, Q3, R14 (R1 OMITTED)
6. COMPONENTS DESIGNATED ★ REPRESENT, IF EMPLOYED, THE COMPONENTS OF THE FREQUENCY MODULE ASSEMBLY
7. LAST REFERENCE DESIGNATORS USED ON TOP ASSEMBLY
   A9, C2, DS3, E1, J6, M1, Q2, R34, S5, T1, TB1
8. THE FUNCTIONS PER CONTACT NO. SHOWN ON S3-6 AND S3-12 ARE TYPICAL FOR ALL DECKS OF S3
9. ARROWS THRU SWITCH AND POTENTIOMETER WIPERS INDICATE CW ROTATION
10. THE FOLLOWING ARE FUNCTIONS FOR THE TOP ASSEMBLY SWITCHES
    - S1 — VOLTS RMS
    - S2 — VARIABLE UNCAL
    - S3 — FUNCTION
    - S4 — PHASE SHIFT 10°
    - S5 — REFERENCE LEVEL AND POWER
11. USE ONLY FOR SERIAL NO 401 AND UP

ITEM	PART NO	DESCRIPTION	QUANTITY REQUIRED
		LIST OF MATERIAL	

PROPRIETARY STATEMENT

THIS DOCUMENT IS SOLELY INFORMATION AND MATTER FURNISHED BY THE SINGER CO. AND IS NOT TO BE USED FOR ANY PURPOSE EXCEPT UNDER AGREEMENT WITH THE SINGER CO. NOR IS ITS POSSESSION THEREIN CONFERS OR TRANSFERS ANY RIGHT TO REPRODUCE OR DISCLOSE ITS CONTENTS IN WHOLE OR IN PART WITHOUT THE WRITTEN PERMISSION FROM THE SINGER CO.

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES; TOLERANCES ON DIMENSIONS: DECIMAL ANGULAR; 2 PLACE ±; 3 PLACE ±; MATERIAL; FINISH; MODEL NO PAV-4A

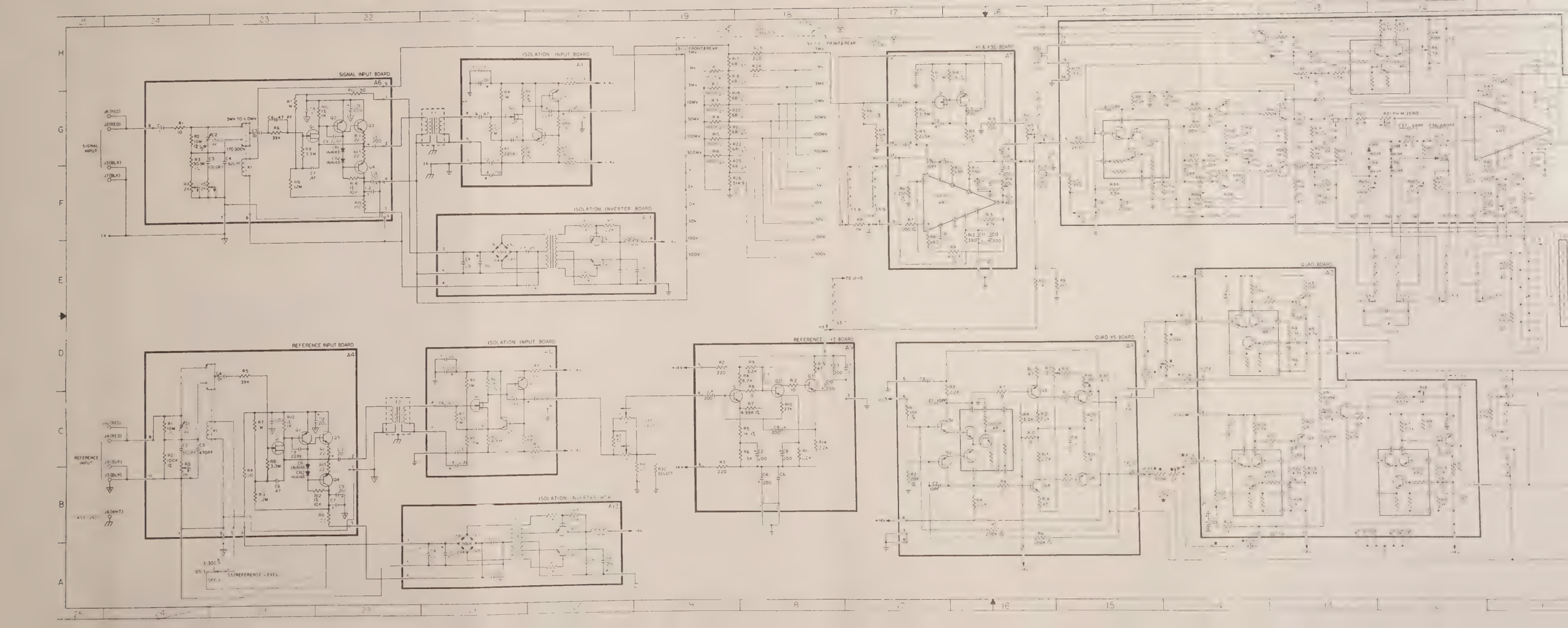
CONTRACT NO; NAME; DATE; DRAWN; CHECK; ENGR APPROVAL; MFG APPROVAL

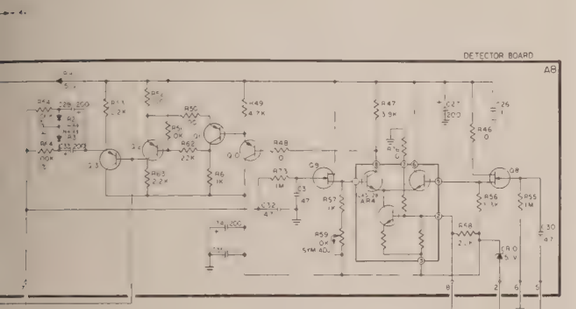
SINGER
THE SINGER CO. METRICS DIV.
SARATOGA, CALIFORNIA

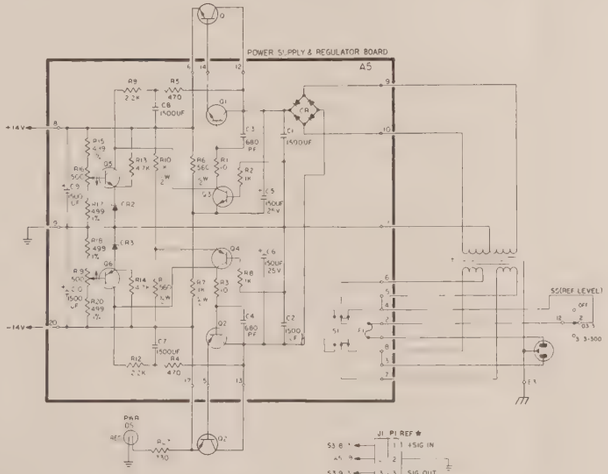
HEMATIC DIAGRAM, PHASE ANGLE VOLTMETER

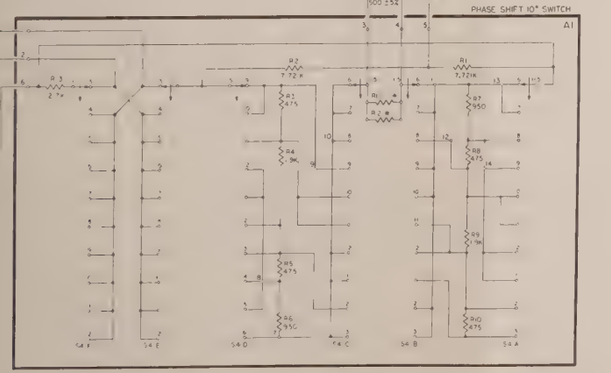
SIZE C; CODE IDENT NO 71468; DWG NO C 88869; SCALE; SHEET OF

Figure 4-6. Schematic Diagram, PAV-4A (S/N 401 and up)


SIGNAL INPUT BOARD
A6
ISOLATION INPUT BOARD
A1
ISOLATION INVERTER BOARD
A1
REFERENCE INPUT BOARD
A4
ISOLATION INPUT BOARD
A1
ISOLATION INVERTER BOARD
A1
REFERENCE +5 BOARD
A1
QUAD X5 BOARD
A2
QUAD BOARD
A2
X1 & X30 BOARD
A1
SIGNAL INPUT
REFERENCE INPUT
3MV TO 300V
1MV
3MV
10MV
30MV
100MV
300MV
1V
3V
10V
30V
100V
300V
FRONT & REAR
TO J1-15
+14V
-14V
+5V
R21 OHM ZERO
SELECT







J1 P1 REF ★

S3-8 *	1	1	45IG IN
A9-9	2	2	
S3-9 *	3	3	SIG OUT
A7-9	4	4	
A8-8	5	5	VCO
	6	6	SPARE
A5-A	7	7	+14V
	8	8	+ 4V
A4-3	9	9	DIFF OUTPUT
A2-2	10	10	DIFF SUM
A3-C	11	11	DIFF IN
A9-9	12	12	
A3-6	13	13	REF OUT
	14	14	
S3-7 4	15	15	∅REF IN
A7-8	A	A	
	B	B	
A7-10	C	C	
	D	D	
A8-*	E	E	VCC(EXT IN)
	F	F	SPARE
	H	H	-14V
A5-10	J	J	-14V
A2-21	K	K	INT OUTPUT
A2-6	L	L	INT SUM
A3-10	M	M	INT IN
	N	N	
A9-19	P	P	
	R	R	
TP 14	S	S	LOCK INDICATOR

NOTES

1. RESISTOR VALUES IN OHMS, TOLERANCE ±10%, ¼W UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED
3. COMPONENTS ON BOARD A1 DESIGNATED THUS ® ARE TO BE SELECTED AT TEST.
4. ALL AREAS ENCLOSED BY A HEAVY LINE REPRESENT INDIVIDUAL CIRCUIT BOARD ASSEMBLIES, UNLESS OTHERWISE SPECIFIED. ALL COMPONENTS OUTSIDE OF THESE AREAS ARE PART OF THE PAV TOP ASSEMBLY NO. A 002712-002.
5. THE LAST REFERENCE DESIGNATOR USED ON BOARD:
   - A1 — R13, S1
   - A2 — AR3, C11, Q4, R26
   - A3 — AR1, C4, D6, R21
   - A4 — C12, K1, Q4, R13, CR2 (C5 OMITTED)
   - A5 — C10, CR3, F1, D6, R20, S1
   - A6 — C13, K1, Q4, R15, CR2
   - A7 — AR1, C14 R14
   - A8 — AR4 C40, CR8 Q13 R77 (C28 AND R10 OMITTED)
   - A9 — C10, Q3, R14 (R1 OMITTED)
   - A10, A12 — R9, C8, Q3
   - A11, A13 — R3, C6, CR4, Q2, L1, T1
6. COMPONENTS DESIGNATED ★ REPRESENT, IF EMPLOYED, THE COMPONENTS OF THE FREQUENCY MODULE ASSEMBLY.
7. LAST REFERENCE DESIGNATORS USED ON TOP ASSEMBLY #9, C2, D53, E1, J6, M1, Q2, R34, S5, T1, TB1
8. THE FUNCTIONS PER CONTACT NO. SHOWN ON S3-6 AND S3-12 ARE TYPICAL FOR ALL DECKS OF S3.
9. ARROWS THRU SWITCH AND POTENTIOMETER WIPERS INDICATE CW ROTATION
10. THE FOLLOWING ARE FUNCTIONS FOR THE TOP ASSEMBLY SWITCHES
    - S1 — VOLTS PHS
    - S2 — VARIABLE UNCAL
    - S3 — FUNCTION
    - S4 — PHASE SHIFT 10°
    - S5 — REFERENCE LEVEL AND POWER
11. USE ONLY FOR SERIAL NO 401 AND UP
12. ⏚ DENOTES SIGNAL COMMON ⏚ DENOTES REFERENCE COMMON

REVISIONS

ZONE	DESCRIPTION	DATE	APPROVED

QUANTITY REQUIRED	DESCRIPTION	PART NO

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DIMENSIONS
DEC PLACE ANGULAR
1 PLACE
2 PLACE
MATERIAL

CONTRACT NO.

	NAME	DATE
DRAWN		
CHK'D		
ELECTRONICS		
MECH ENGR		
APPROVED		

SINGER
THE SINGER CO METRICS DIV
GENEVA DEPT LOS ANGELES, CALIF

SCHEMATIC DIAGRAM, PHASE ANGLE VOLTMETER

MODEL NO PAV-48

SIZE C | CODE IDENT NO 88869 | DWG NO 8500-0

SCALE | SHEET 1 OF 1

PROPRIETARY STATEMENT

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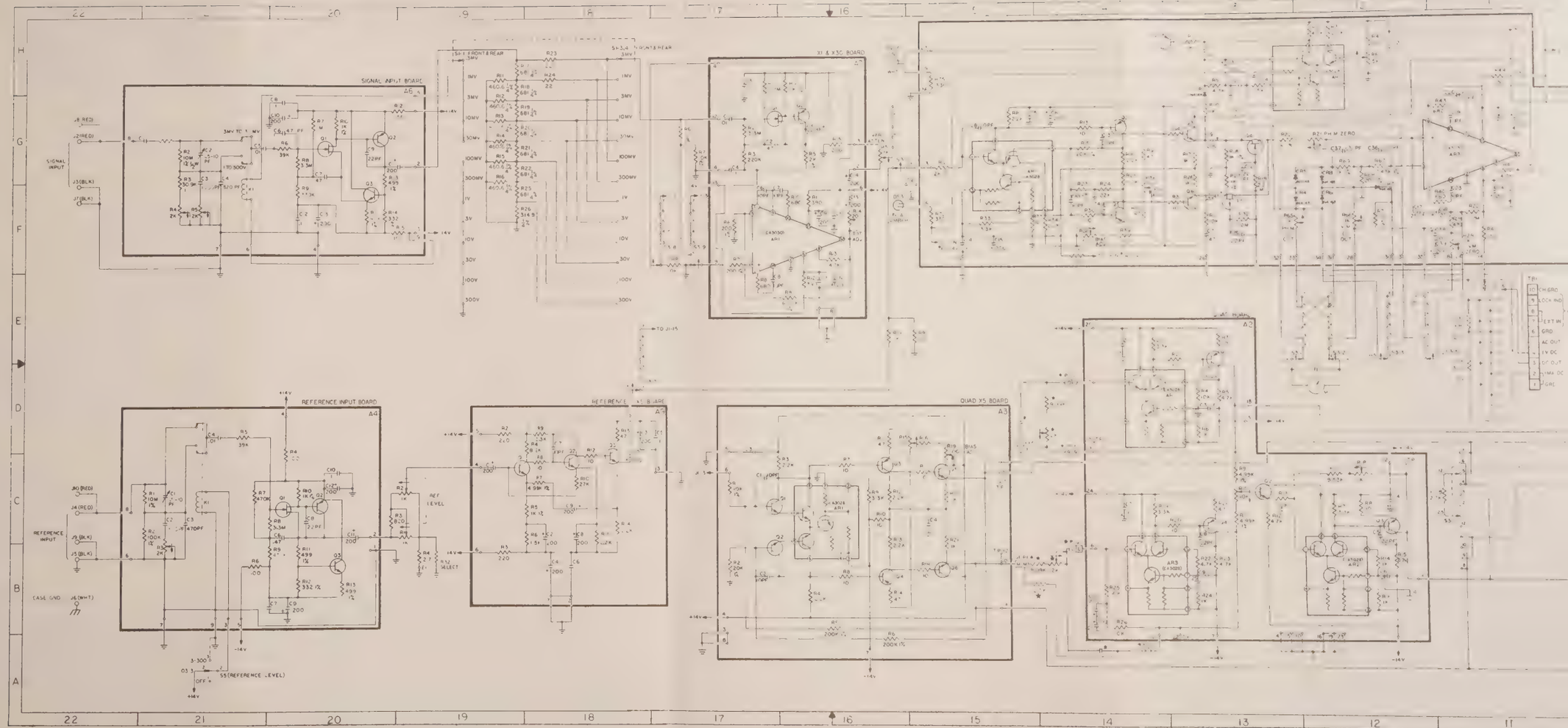

SIGNAL INPUT BOARD
A5
REFERENCE INPUT BOARD
A4
X1 & X3C BOARD
A1
REFERENCE X1 BOARD
A2
QUAD X5 BOARD
A3
SIGNAL INPUT
REFERENCE INPUT
J8(RED)
J2(RED)
J3(BLK)
J7(BLK)
J6(WHT)
CASE GND
J4(RED)
J9(BLK)
J5(BLK)
1MV
3MV
10MV
30MV
100MV
300MV
1V
3V
10V
30V
100V
300V
+14V
-14V
REF LEVEL
RANGE SELECT
S5(REFERENCE LEVEL)
OFF
TO J1-15
TP1
ZERO
GRD
1V DC
1MA DC

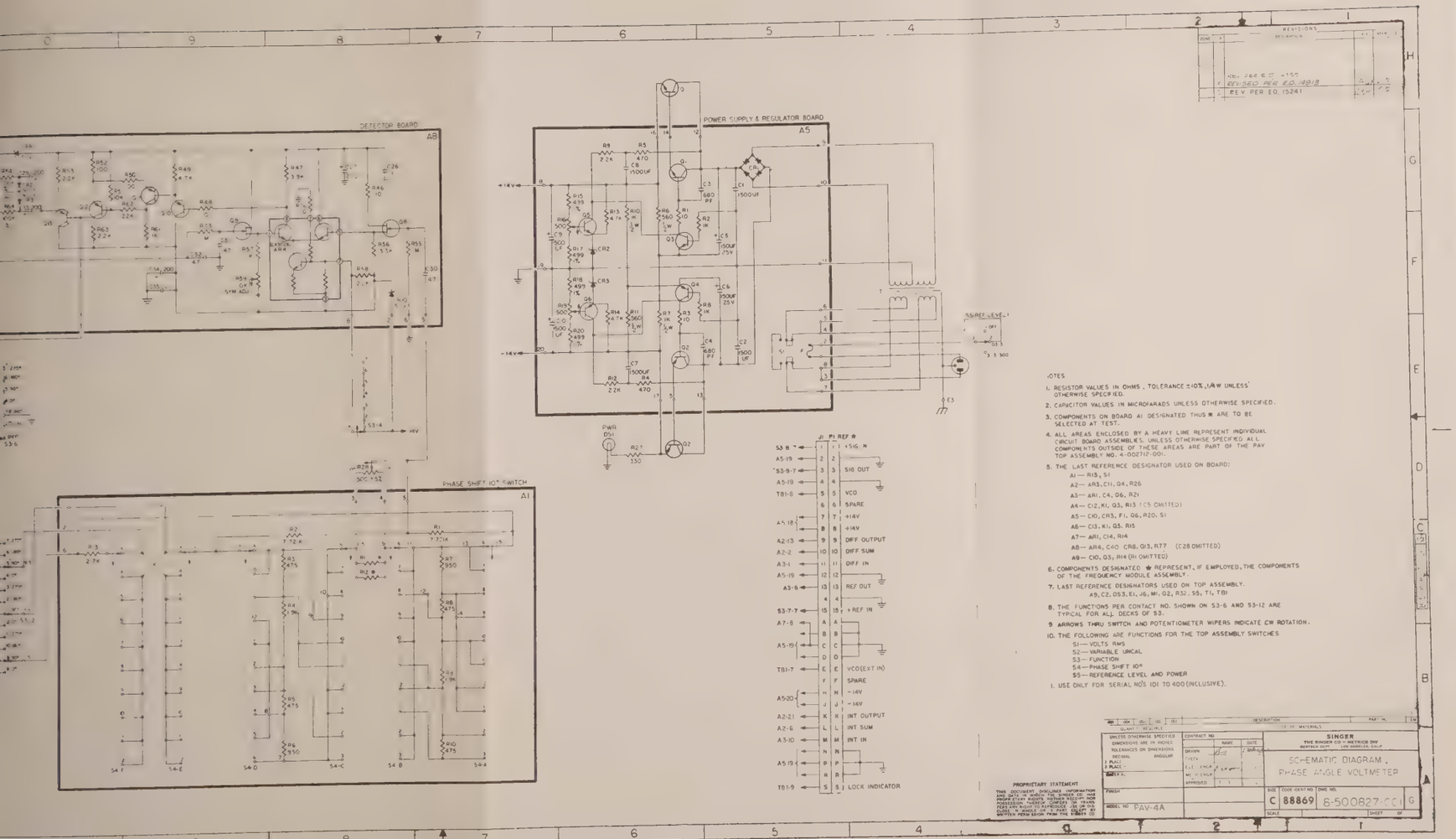
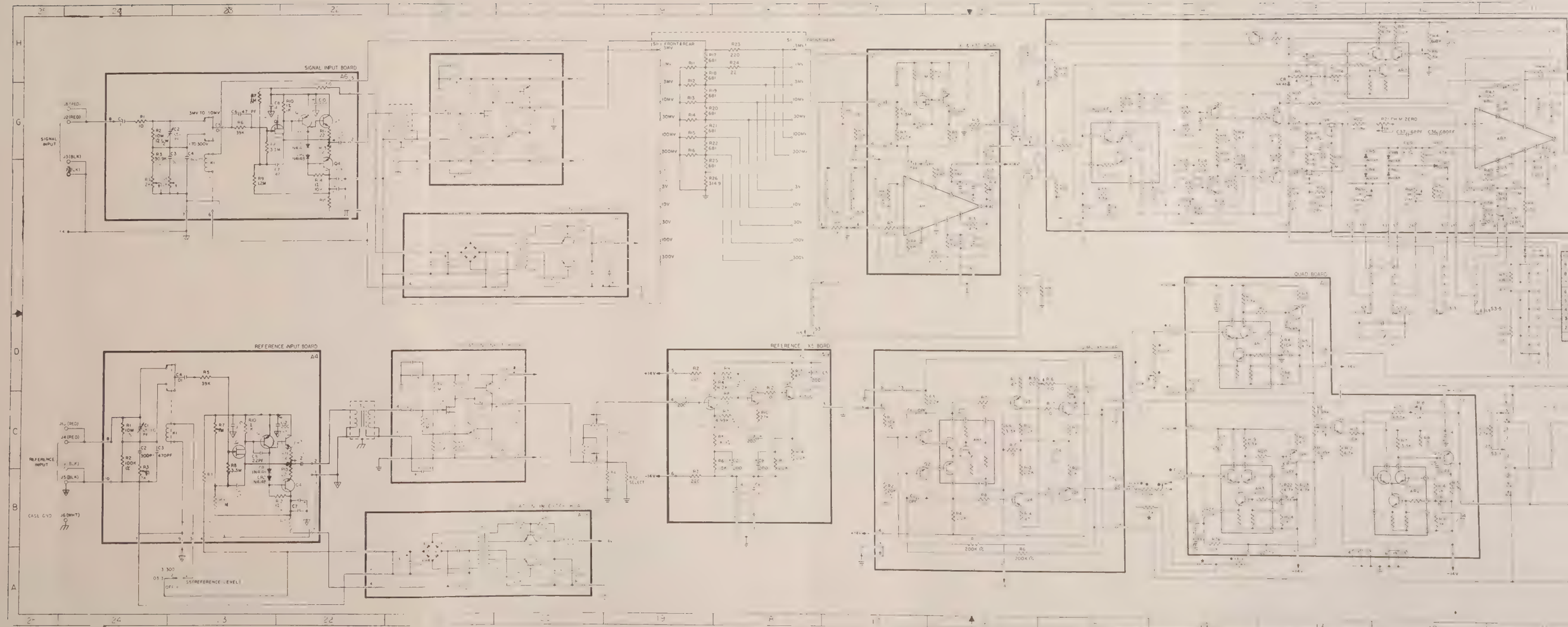

DETECTOR BOARD
A8
POWER SUPPLY & REGULATOR BOARD
A5
PHASE SHIFT 10° SWITCH
A1
J1 P1 REF Ø
+SIG. N
SIG OUT
VCO
SPARE
+14V
+14V
DIFF OUTPUT
DIFF SUM
DIFF IN
REF OUT
+REF IN
SPARE
-14V
-16V
INT OUTPUT
INT SUM
INT IN
VCO(EXT IN)
LOCK INDICATOR
NOTES
1. RESISTOR VALUES IN OHMS, TOLERANCE ±10%, ¼W UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. COMPONENTS ON BOARD A1 DESIGNATED THUS ✱ ARE TO BE SELECTED AT TEST.
4. ALL AREAS ENCLOSED BY A HEAVY LINE REPRESENT INDIVIDUAL CIRCUIT BOARD ASSEMBLIES. UNLESS OTHERWISE SPECIFIED ALL COMPONENTS OUTSIDE OF THESE AREAS ARE PART OF THE PAV TOP ASSEMBLY NO. 4-002717-001.
5. THE LAST REFERENCE DESIGNATOR USED ON BOARD:
A1— R13, S1
A2— AR3, C11, Q4, R26
A3— AR1, C4, Q6, R21
A4— C12, K1, Q3, R13 (C9 OMITTED)
A5— C10, CR3, F1, Q6, R20, S1
A6— C13, K1, Q5, R15
A7— AR1, C14, R14
A8— AR4, C40 CR8, Q13, R77 (C28 OMITTED)
A9— C10, Q3, R14 (R1 OMITTED)
6. COMPONENTS DESIGNATED ✱ REPRESENT, IF EMPLOYED, THE COMPONENTS OF THE FREQUENCY MODULE ASSEMBLY
7. LAST REFERENCE DESIGNATORS USED ON TOP ASSEMBLY.
A9, C2, DS3, E1, J6, M1, Q2, R32, S5, T1, TB1
8. THE FUNCTIONS PER CONTACT NO. SHOWN ON S3-6 AND S3-12 ARE TYPICAL FOR ALL DECKS OF S3.
9. ARROWS THRU SWITCH AND POTENTIOMETER WIPERS INDICATE CW ROTATION.
10. THE FOLLOWING ARE FUNCTIONS FOR THE TOP ASSEMBLY SWITCHES
S1— VOLTS RMS
S2— VARIABLE UNCAL
S3— FUNCTION
S4— PHASE SHIFT 10°
S5— REFERENCE LEVEL AND POWER
11. USE ONLY FOR SERIAL NOS 101 TO 400 (INCLUSIVE).
REVISIONS
REVISED PER E.O. 14918
REV. PER E.O. 15241
PROPRIETARY STATEMENT
SINGER
THE SINGER CO — METRICS DIV
SCHEMATIC DIAGRAM,
PHASE ANGLE VOLTMETER
MODEL NO PAV-4A
C 88869
6-500827-C01
G

Figure 4-8. Schematic Diagram, PAV-4A (S/N < 401)


SIGNAL INPUT BOARD
A6
REFERENCE INPUT BOARD
A4
QUAD BOARD
REFERENCE X5 BORD
SIGNAL INPUT
REFERENCE INPUT
FRONT/REAR
R23 220
R24 22
R17 681
R18 681
R19 681
R20 681
R21 681
R22 681
R25 681
R26 3161
1MV
5MV
10MV
30MV
100MV
300MV
1V
3V
10V
30V
100V
300V
R2 ZERO
C36 680PF
C37 68PF
200K
200K
-14V
+14V

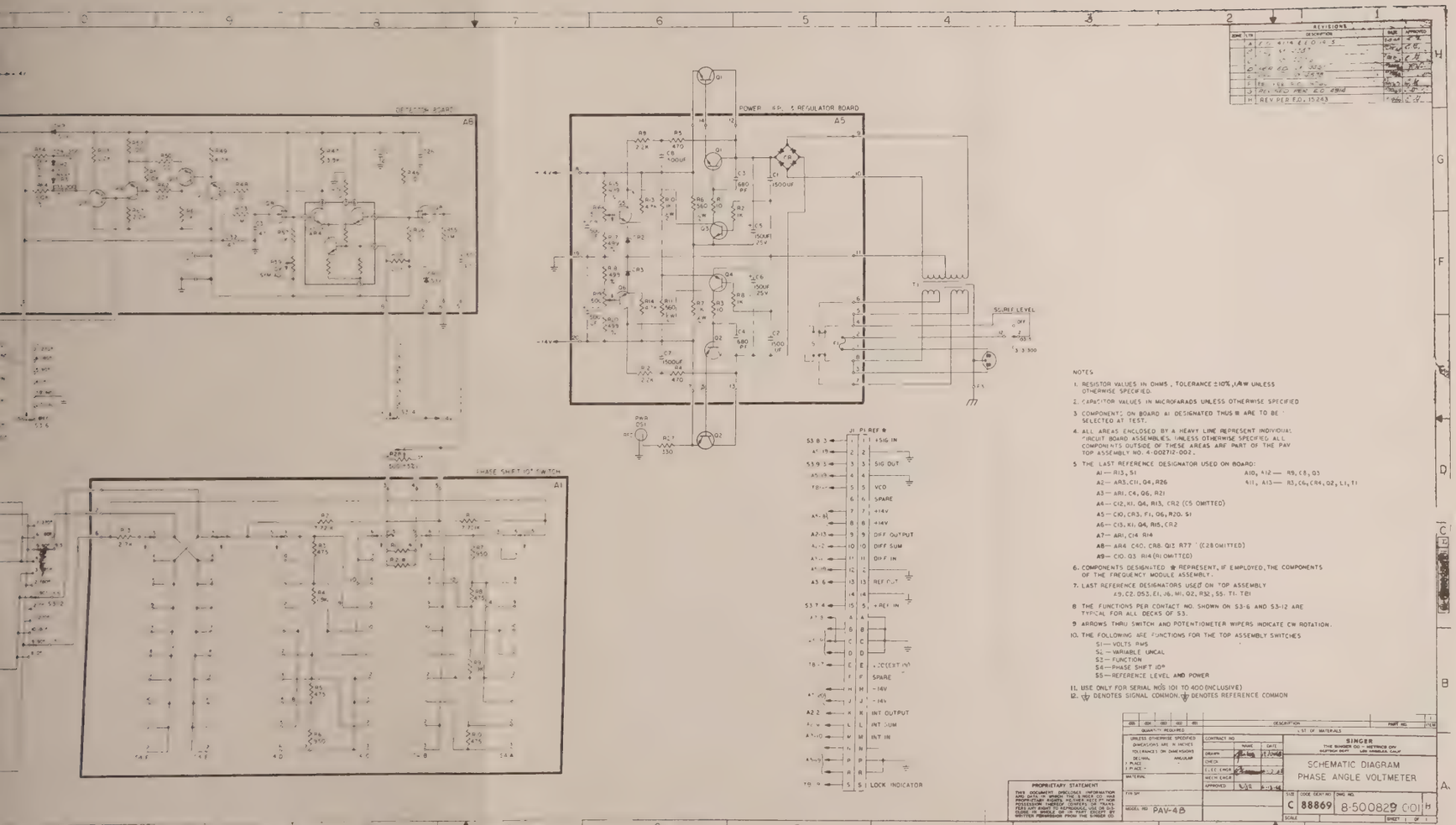
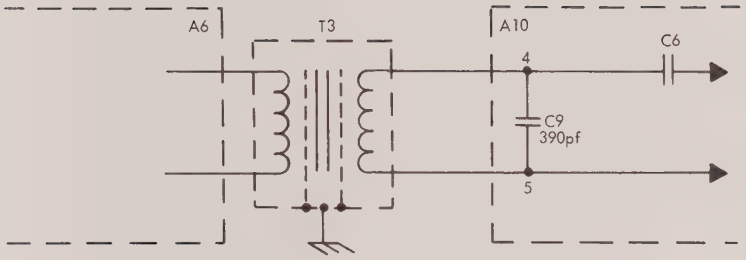

DEFLECTION BOARD A6
POWER S.P.S. REGULATOR BOARD A5
PHASE SHIFT 10° SWITCH A1
J1 P1 REF ♦
+SIG IN
SIG OUT
VCO
SPARE
+14V
DIFF OUTPUT
DIFF SUM
DIFF IN
REF OUT
+REF IN
SPARE
-14V
-14V
INT OUTPUT
INT SUM
INT IN
LOCK INDICATOR
SS REF LEVEL
PWR OFF
NOTES
1. RESISTOR VALUES IN OHMS, TOLERANCE ±10%, ½W UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED
3 COMPONENTS ON BOARD A1 DESIGNATED THUS ⊞ ARE TO BE SELECTED AT TEST.
4. ALL AREAS ENCLOSED BY A HEAVY LINE REPRESENT INDIVIDUAL CIRCUIT BOARD ASSEMBLIES. UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS OUTSIDE OF THESE AREAS ARE PART OF THE PAV TOP ASSEMBLY NO. 4-002712-002.
5 THE LAST REFERENCE DESIGNATOR USED ON BOARD:
A1— R13, S1
A2— AR3, C11, Q4, R26
A3— AR1, C4, Q6, R21
A4— C12, K1, Q4, R13, CR2 (C5 OMITTED)
A5— C10, CR3, F1, Q6, R20, S1
A6— C13, K1, Q4, R15, CR2
A7— AR1, C14 R14
A8— AR4 C40, CR8, Q12 R77 (C28 OMITTED)
A9— C10, Q3 R14 (R1 OMITTED)
A10, A12— R9, C8, Q3
A11, A13— R3, C6, CR4, Q2, L1, T1
6. COMPONENTS DESIGNATED ✱ REPRESENT, IF EMPLOYED, THE COMPONENTS OF THE FREQUENCY MODULE ASSEMBLY.
7. LAST REFERENCE DESIGNATORS USED ON TOP ASSEMBLY A9, C2, DS3, E1, J6, M1, Q2, R32, S5, T1, TB1
8 THE FUNCTIONS PER CONTACT NO. SHOWN ON S3-6 AND S3-12 ARE TYPICAL FOR ALL DECKS OF S3.
9 ARROWS THRU SWITCH AND POTENTIOMETER WIPERS INDICATE CW ROTATION.
10. THE FOLLOWING ARE FUNCTIONS FOR THE TOP ASSEMBLY SWITCHES
S1— VOLTS RMS
S2— VARIABLE UNCAL
S3— FUNCTION
S4— PHASE SHIFT 10°
S5— REFERENCE LEVEL AND POWER
11. USE ONLY FOR SERIAL NOS 101 TO 400 (INCLUSIVE)
12. ⏚ DENOTES SIGNAL COMMON ⏚ DENOTES REFERENCE COMMON
REVISIONS
DESCRIPTION
REV PER E.O. 15243
LIST OF MATERIALS
PROPRIETARY STATEMENT
SINGER
SCHEMATIC DIAGRAM
PHASE ANGLE VOLTMETER
MODEL NO PAV-4B
SIZE C
CODE IDENT NO 88869
DWG NO 8-500829 001
SCALE
SHEET 1 OF 1

Figure 4-9. Schematic Diagram, PAV-4B (S/N < 401)



The schematic for Model PAV-4C is identical to that of PAV-4B with the exception that an additional capacitor, C9, is added across pins 4 and 5 of A10 (secondary of T3).

Figure 4-10. Schematic Diagram, PAV-4C

SECTION V

MAINTENANCE

5-1. SCHEDULED MAINTENANCE

5-2. The following schedule is recommended for maximum accuracy:

a. Every 90 days.

(1) Check for mechanical defects such as damaged components or insulation, loose wires, loose hardware, etc.

(2) Perform full calibration procedure (see para. 5-4 onwards).

b. Yearly.

(1) Clean unit with a vacuum cleaner.

(2) Examine switches and pots for intermittant operation. Normally, conventional contact cleaner material will cure an intermittant problem. However, it should be remembered that it is normal for switches to require more frequent cleaning as they become more worn. Eventually, a worn out switch will have to be replaced. Normally, this occurs somewhere between 200,000 and 1,000,000 operations.

c. No other scheduled maintenance is required.

5-3. UNSCHEDULED MAINTENANCE

a. Repairs. Conventional trouble-shooting techniques are recommended for repair by the user. Consult applicable schematics and parts list for assistance. It is not always necessary to completely recalibrate a unit when a component is replaced. If only the power supply is repaired it may only be necessary to readjust the output voltage potentiometers for + and – 14VDC.

NOTE

The PAV-4 contains a short circuit proof power supply which requires manual reset to restore normal operation. Reset is done by simply turning the AC power switch off and then back on.

b. Remounting "degrees" dial when it is necessary to remount the DEGREES potentiometer dial, proceed as follows:

(1) Connect ohmmeter between S and CW of R28.

(2) Adjust R28 for minimum resistance (2 ohm maximum).

(3) Reinstall with "0" directly in-line with pointer on panel.

(4) Tighten knob setscrew, and re-check resistance at "0" setting.

c. Remounting VF Dial when it is necessary to remount the FREQUENCY potentiometer dial, proceed as follows:

(1) Connect ohmmeter between pins 1 and 3 of R86.

(2) Adjust R86 for a resistance reading of 10 ± 2 ohms.

(3) Reinstall with lowest frequency mark on the dial directly in-line with pointer on panel.

(4) Tighten knob setscrew and recheck resistance at minimum frequency setting.

5-4. GENERAL CALIBRATION REQUIREMENTS.

5-5. The possible number of combinations of plug-in types, main-frames, and frequencies is virtually unlimited. Because of this, a separate calibration procedure for every combination cannot be given. Instead, a comprehensive procedure valid for all combinations is given (paragraph 5-8 onwards). It is broken down into steps, of which only some are appropriate to a specific plug-in/main-frame, combination. The user must select the appropriate steps by referring to figure 5-1: Calibration Procedure Selection Chart.

5-6. Since the calibration of the main-frame is limited by what frequencies and types of plug-ins are to be used, it is necessary to point out some of the calibration considerations for various combinations:

a. More than one plug-in can be calibrated to work in a given main-frame. However, once a plug-in has been calibrated in a given main-frame, the plug-in calibration will not be valid in any other main-frame. All the plug-ins that are to be used with a given mainframe should be calibrated at the same

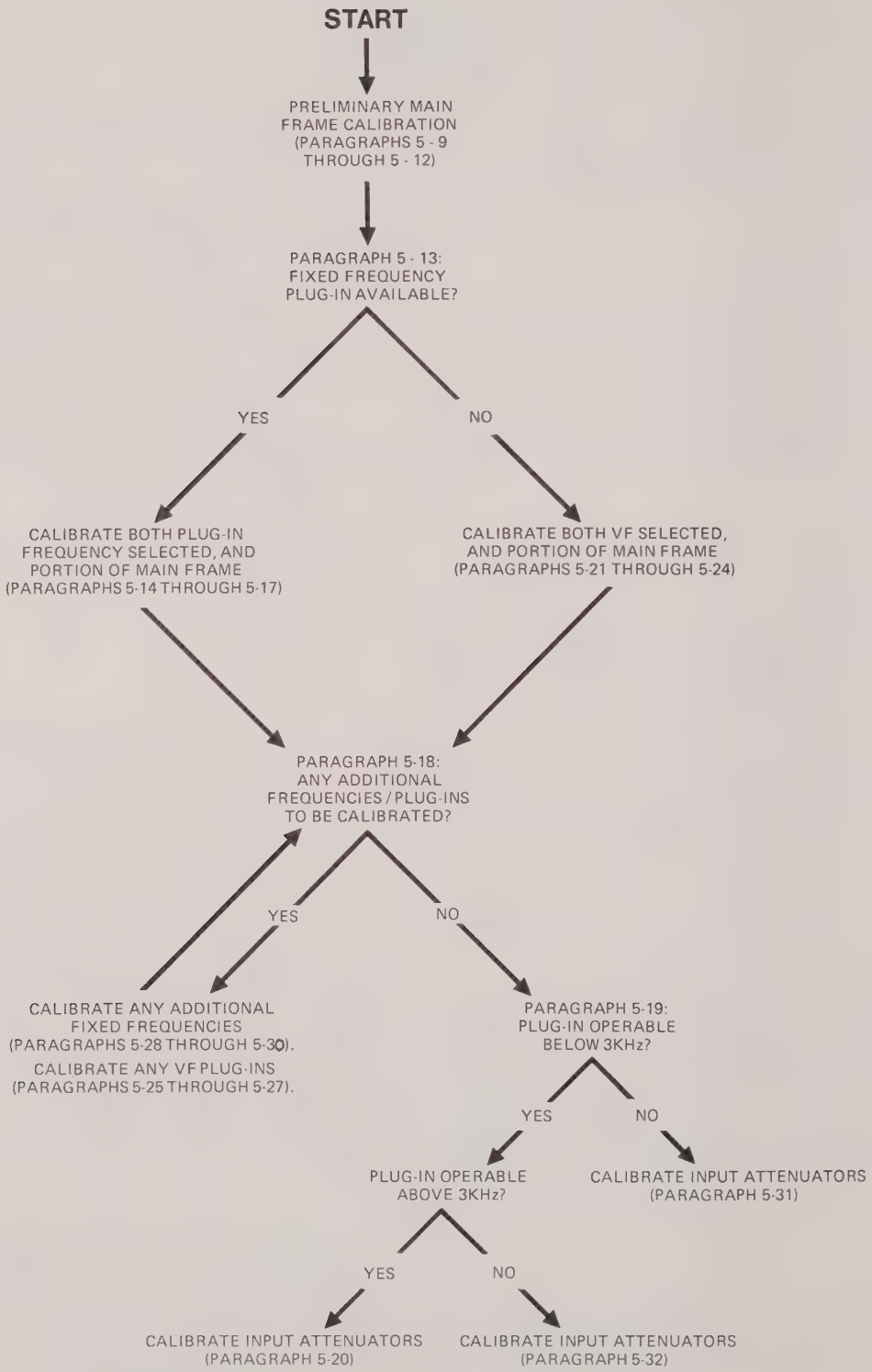

START
PRELIMINARY MAIN FRAME CALIBRATION (PARAGRAPHS 5 - 9 THROUGH 5 - 12)
PARAGRAPH 5 - 13: FIXED FREQUENCY PLUG-IN AVAILABLE?
YES
NO
CALIBRATE BOTH PLUG-IN FREQUENCY SELECTED, AND PORTION OF MAIN FRAME (PARAGRAPHS 5-14 THROUGH 5-17)
CALIBRATE BOTH VF SELECTED, AND PORTION OF MAIN FRAME (PARAGRAPHS 5-21 THROUGH 5-24)
PARAGRAPH 5-18: ANY ADDITIONAL FREQUENCIES / PLUG-INS TO BE CALIBRATED?
YES
NO
CALIBRATE ANY ADDITIONAL FIXED FREQUENCIES (PARAGRAPHS 5-28 THROUGH 5-30).
CALIBRATE ANY VF PLUG-INS (PARAGRAPHS 5-25 THROUGH 5-27).
PARAGRAPH 5-19: PLUG-IN OPERABLE BELOW 3KHz?
YES
NO
PLUG-IN OPERABLE ABOVE 3KHz?
CALIBRATE INPUT ATTENUATORS (PARAGRAPH 5-31)
YES
NO
CALIBRATE INPUT ATTENUATORS (PARAGRAPH 5-20)
CALIBRATE INPUT ATTENUATORS (PARAGRAPH 5-32)

Figure 5-1. Calibration Procedure Selection Chart

time as the main-frame to minimize the test time required. This will also ensure that the main-frame calibration will be valid at the frequency extremes at which it is to be used.

b. In order to fully calibrate a main-frame so that any plug-in frequency can be calibrated, it is necessary to calibrate the main-frame at the frequency extremes of the range over which it is to be used. This requires plug-in frequency operation at these frequency extremes. The following examples will illustrate the point:

(1) User has PAV-4B main-frame calibrated for use with a 400Hz MF-1 plug-in. Later on the user incorporates a 10KHz frequency set into the MF-1 plug-in. To obtain rated accuracy at 10KHz, a portion of the main-frame (A6R5 and A4R3) must be recalibrated at 10KHz.

(2) User has PAV-4B main-frame with a VF-1 (300Hz to 10KHz) and VF-2 (10KHz to 300KHz). Both plug-ins must be used to fully calibrate the main-frame over the full frequency range from 300Hz to 300KHz, because of the frequency characteristics of the input attenuators in the signal and reference channels.

c. The calibration controls in the signal and reference sections of the main-frame should be calibrated as follows:

(1) A6R4: This control sets the low frequency amplitude division ration of the signal input attenuator. It should therefore be calibrated in the TOTAL mode at the minimum main-frame operating frequency.

(2) A6C2, A4C1: These controls primarily affect the phase shift through the attenuators at low frequencies. Therefore, they should be calibrated in the 90^{o} mode at the minimum plug-in operating frequency. If the lowest operating frequency is above 3KHz, then these controls should be set for proper amplitude division ratio at 10KHz in the TOTAL mode. This latter procedure is straight forward for A6C2; however, A4C1 must be set in the REF LEVEL mode for flat frequency response up to 10KHz.

(3) A6R5, A4R3: At high plug-in operating frequencies, these controls affect the phase shift through the attenuators. If the maximum plug-in operating frequency is below 3KHz, then it is only necessary to set A6R5 for proper amplitude division ratio at 300 KHz.

d. At certain operating frequencies, mostly near the lower frequency limit, small beat notes (oscillations) may be observed when using the VF plug-in. If the magnitude of the oscillation is objectionable, it can be eliminated by simply changing the operating frequency slightly. If this is not possible, another alternative is to shift the frequency of the I.F. Oscillator. The maximum allowable offset is ±0.5%. It is normal for the 1VDC output on the rear panel to indicate a larger amplitude oscillation than what appears on the meter, due to the shorter time constant.

5-7. Test Equipment Required: Refer to Table 5-1.

5-8. CALIBRATION PROCEDURES.

5-9. PRELIMINARY MAIN-FRAME CALIBRATION.

TABLE 5-1. TEST EQUIPMENT

ITEM	MINIMUM USE SPECIFICATION	ACCEPTABLE MODEL
Oscillator	3 VRMS, 30Hz to 300KHz, 1% Dist.	HP652A or HP651B
Counter	30Hz to 300KHz, 0.1%	HP5532A
Oscilloscope	1MC, 0.01V/CM	Tektronix 543B/1A7A
AC True RMS Diff. Voltmeter	30Hz to 300KHz	Fluke 931AB
AC/DC Diff. Voltmeter	30Hz to 20KHz	Fluke 873AB
Multi-Function Meter	R x 1, 1VDC full scale	HP427A

a. Adjust mechanical zero of meter, if required.

b. Set DEGREES switch and potentiometer to $+0^{o}$.

c. Set VOLTS-RMS variable attenuator fully clockwise to CAL position.

d. Set FUNCTION switch to TOTAL.

e. Insert plug-in (fixed frequency type preferred, but not required).

f. Set plug-in to lowest operating frequency.

g. Set VOLTS-RMS switch to 300.

h. Short SIGNAL and REFERENCE inputs with a short (6" max) jumper.

i. Remove top and bottom dust covers.

j. Check position of 115/230V switch (bottom side) for desired setting.

k. Connect AC power to unit.

l. Turn REF LEVEL switch to 0.03V - 3V position.

m. AC PWR lamp should light.

5-10. DC Voltage Adjustments.

a. Measure +14V between A5 - 18 and chassis, with DC Diff. VM. Voltage should measure +14.0 ±0.07 Volt. Adjust A5R16 if required. Refer to Figure 5-2 for location of components.

b. Measure −14V between A5 - 20 and chassis, with DC Diff. VM. Voltage should measure −14.0 ±0.07V. Adjust A5R19, if required.

c. Measure 0V between collector of A8Q5 and chassis, with DC VM. Voltage should measure 0 ±0.5V. Adjust A8R38, if required.

d. Measure 0V between A3 - 11 and chassis, with DC VM. Voltage should measure 0 ±0.5V. Adjust A3R19, if required.

CAUTION

ACCIDENTAL SHORTING OF A3-11 OR A3-12 TO CHASSIS MAY CAUSE PERMANENT DAMAGE TO THE A3 BOARD.

5-11. Total Calibration.

a. Connect a short jumper between A8 - 3 and chassis.

b. Adjust A8R28 for a minimum reading on meter. Remove the A8-3 jumper.

c. Connect test set-up shown in Figure 5-3.

d. Set Test Oscillator output to 0.03V ±0.2% at 300Hz. Set PAV-4 VRMS switch to 0.03.

e. Adjust A7R14 if required, to read exactly +3.0 on meter.

f. Change test frequency to 300KHz.

g. Adjust A8C20 if required, to read +2.9 on meter.

h Change input test voltage and frequency to 1.0V ±0.2% at 300Hz. Set PAV-4 VRMS switch to 1.0.

i. Adjust A6R4 if required, to read exactly +1.0 on meter.

j. Measure +1V between pin 4 on TB-1 (rear panel) and chassis, with DC Diff. VM. Voltage should measure +1.0 ±0.005V. Adjust A8R66, if required.

5-12. OVLD Calibration

a. Change input test voltage to 0.12V ±1%. Set PAV-4 VRMS switch to 0.01.

b. Adjust A8R6 until OVLD lamp just turns on. Reduce input test voltage to 0.11V ±1%. OVLD lamp should turn off.

5-13. Type of Plug-in Required for Further Calibration:

a. If a fixed frequency plug-in (Model SF-1 or MF-1) is available to calibrate with the PAV-4, then continue on to paragraph 5-14.

b. If a fixed frequency plug-in is not available, then a Model VF-1 or 2 must be used. Proceed directly to paragraph 5-21.

5-14. PAV-4 REFERENCE CHANNEL CALIBRATION WITH FIXED-FREQUENCY PLUG-IN.

5-15. FUNDAMENTAL Calibration.

a. Set plug-in and test oscillator to lowest nominal (center) operating frequency ±0.1%.

b. Set PAV-4 FUNCTION switch to FUND.

c. Change input test voltage to 0.03V ±0.2%. Set PAV-4 VOLTS-RMS switch to 0.03.

d. Adjust FUND trimmer R1, on the frequency network board in the plug-in, if required to read exactly +3.0 on meter.

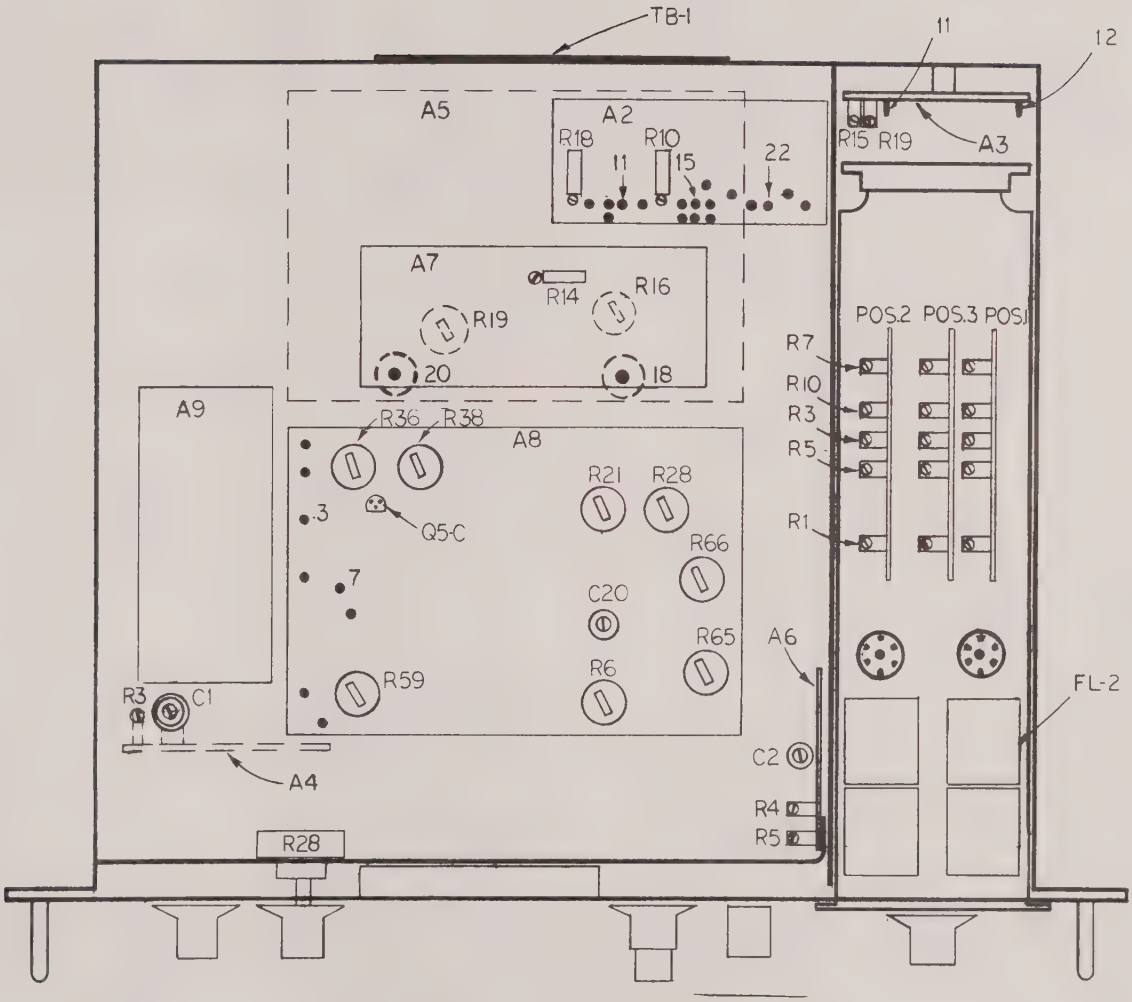


Figure 5-2. Calibration Test Point Locations, Main-frame

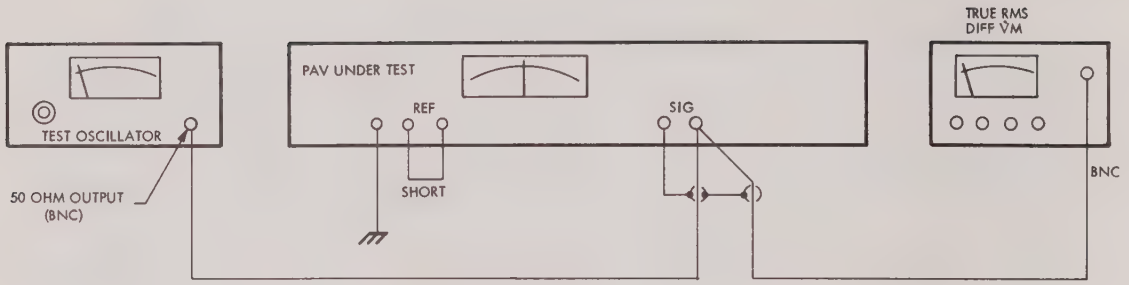


Figure 5-3. Voltmeter Test Circuit

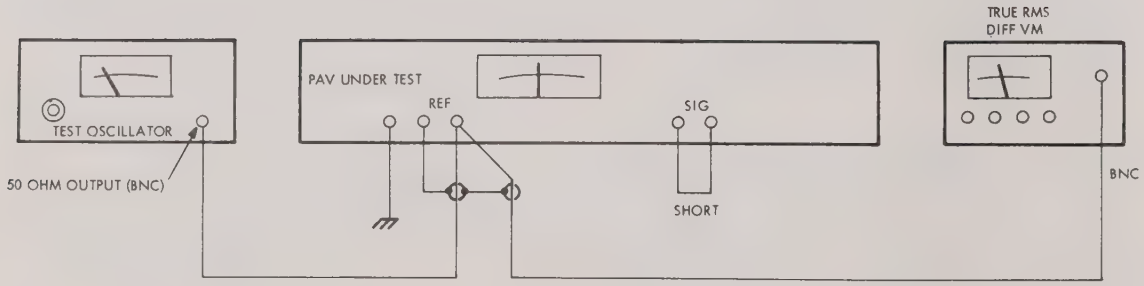


Figure 5-4. Reference Channel Test Circuit

5-16. Reference Channel Calibration

a. Connect test set-up shown in Figure 5-4.

b. Set test oscillator voltage to 0.1V ±0.2%. Frequency must be maintained at nominal ±0.1%.

c. Set PAV-4 FUNCTION switch to REF LEVEL.

d. Adjust REF LEVEL VARIABLE for REF LEVEL mark on the meter.

e. Set PAV-4 FUNCTION switch to 0°.

f. Measure AC Voltage between A3-12 (0° reference) and chassis, with AC Diff. VM on 1V range Record reading.

CAUTION

ACCIDENTAL SHORTING OF A3-11 OR A3-12 TO CHASSIS MAY CAUSE PERMANENT DAMAGE TO A3 BOARD.

g. Measure AC Voltage between A3-11 (180° Reference) and chassis with AC Diff. VM on 1V range. Record reading.

h. Compute the average value obtained in steps f and g above.

i. With the AC Diff. VM on either A3-11 or 12, adjust A3R15 until voltage measured equals that computed in step h above. Voltage at A3-11 should now equal the voltage at A3-12 ±0.1%. Some minor readjustment may be necessary.

j. Measure AC Voltage between A2-22 (270° Reference) and chassis, with AC Diff. VM on 1V range.

k. Adjust integrating amplifier trimmer R10 on the frequency network board, if required until voltage at A2-22 equals that measured at A3-11 and 12 ±0.1%.

l. Measure AC Voltage between A2-15 (270° Reference) and chassis, with AC Diff. VM on 1V range.

m. Adjust differentiator amplifier trimmer R7 on the frequency network board, if required, until voltage at A2-15 equals that measured at A3-11 and 12 ±0.1%.

n. Measure AC Voltage between A2-11 (90° Reference) and chassis, with AC Diff. VM on 1V range.

o. Adjust A2R18 if required, until voltage at A2-11 equals that measured at A3-11 and 12 ±0.1%.

p. Remove Reference filter (FL2) from plug-in, and jumper pin 5 to 7 in socket. Set PHASING trimmer R5 on frequency network board to mid-range.

q. Vary test oscillator frequency ±5% from nominal, while monitoring the voltage at A2-11 and with AC Diff. VM on 1V range. Maintain a constant (±0.05%) test voltage over this frequency range. Adjust A2R10 if required, to maintain a constant voltage on the meter. Note, the best setting occurs when the voltage increases at both the + and −5% limit compared to the value at center frequency. Trimmer resolution may prevent equality at both limits.

r. Remove jumper, replace filter, and return test oscillator frequency to nominal. Recheck voltage at A3-11, A3-12, A2-22, A2-15, and A2-11 for equality. Readjust if required.

s. Measure 0V between A8-7 and chassis with DC VM. Voltage should measure 0±0.01V. Adjust A8R59 if required.

t. Adjust A8R21 for zero on meter.

u. Connect PAV-4 signal input in parallel with reference input, and set VRMS switch to 0.01. See Figure 5-5. Set FUNCTION switch to 90°.

v. Adjust PHASING trimmer R5 for a null on the meter.

w. Vary test oscillator frequency ±5% from nominal, while observing PAV-4 meter. If meter deviation exceeds ±2% of full scale (±0.2% of input) adjust TRACKING trimmer R3 on frequency network board for minimum deviation.

x. Return test oscillator frequency to nominal, and readjust PHASING trimmer R5 for a null on the meter.

y. The fixed-frequency used above and the mainframe Reference Channel are now calibrated.

5-17. Phase-Sensitive Signal Channel Calibration.

a. Change input test voltage to 31.6VRMS ±0.2%. Readjust REF LEVEL.

b. Set PAV-4 VRMS switch to 0.03, and FUNCTION switch to 0°.

c. Adjust A8R36 for a reading of +3.16 on lower scale of meter. Note, this corresponds to a reading of +1.00 on the upper scale.

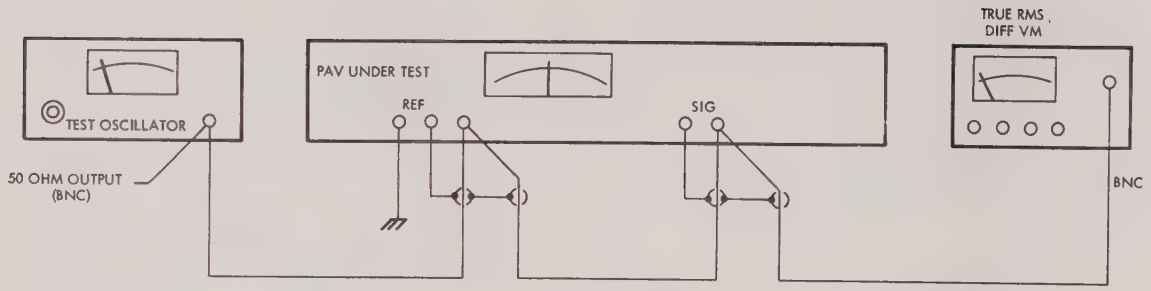


Figure 5-5. Preliminary Reference Channel Test Circuit

d. TOTAL, FUND, and 0° should now all read the same (+3.16) on the PAV-4 meter. 90° should read 0. Adjust A7R14, R1, A8R36, and R5 respectively, if required.

e. Measure +1V between pin 4 on TB-1 (rear panel) and chassis in 0° mode, with DC Diff. VM. Voltage should measure +1.0 ±0.005V. Adjust A8R65, if required.

5-18. Additional Frequencies/Plug-Ins

a. If there are no additional fixed frequencies or plug-ins to be calibrated, continue on to paragraph 5-19.

b. If there are additional fixed frequencies or fixed frequency plug-ins to be calibrated proceed directly to paragraph 5-28.

c. If there are only VF plug-ins to be calibrated, proceed directly to paragraph 5-25.

5-19. Plug-In Frequencies Required for Further Calibration:

a. If a plug-in(s) is available that will operate both above and below 3KHz, continue on to 5-20.

b. If no plug-ins are available that will operate below 3KHz, proceed directly to 5-31.

c. If no plug-ins are available that will operate above 3KHz, proceed directly to 5-32.

5-20. INPUT ATTENUATOR CALIBRATION FOR UNITS ABOVE AND BELOW 3KHz.

a. Select the plug-in with the lowest operating frequency, and install it in the PAV-4 to be calibrated. Set the plug-in to the lowest operating frequency.

b. Set test oscillator to nominal operating frequency. Use 350Hz for VF-1.

c. Set input test voltage to 3VRMS ±0.2%, and FUNCTION switch to REF LEVEL.

d. With REF LEVEL switch in 0.03 - 3V position adjust VARIABLE for proper level on meter.

e. Set PAV-4 VRMS switch to 0.3, and FUNCTION switch to 90°. Lock VF-1, if used.

f. Adjust A6C2 for a null on the meter.

g. Set VRMS switch to 3.0, and set FUNCTION switch to TOTAL.

h. Set test oscillator to 300Hz.

i. Readjust A6R4 if required, to read exactly +3.0 on meter.

j. Return oscillator frequency to nominal value in step b above, and VRMS switch to 0.3.

k. Set REF LEVEL switch to 3 - 300V position, and readjust VARIABLE for proper level on meter.

l. Set FUNCTION switch to 90°.

m. Adjust A4C1 for a null on the meter.

n. Select the plug-in with the highest operating frequency, and install it in the PAV-4 to be calibrated. Set the plug-in to the highest operating frequency.

o. Set test oscillator to nominal operating frequency. Use 10KHz for VF-1, and 300KHz for VF-2.

p. With REF LEVEL switch in 0.03 - 3V position, adjust variable for proper level on meter.

q. Set FUNCTION switch to 90°. Lock VF if used.

r. Adjust A6R5 for a null on the meter.

s. Set REF LEVEL switch to 3 - 300V position, and readjust VARIABLE for proper level on meter.

t. Set FUNCTION switch to 90°.

u. Adjust A4R3 for a null on the meter.
RE-ADJUST A4C1 - RE-CHECK 3-300 RANGE

v. The PAV-4 main-frame and all the plug-ins are now completely calibrated.

5-21. PAV-4 REFERENCE CHANNEL CALIBRATION WITH VARIABLE FREQUENCY PLUG-IN.

5-22. Preliminary Adjustments.

a. With DC VM, measure the voltage from terminal No. 1 of R86 and chassis at both extremes of the dial. Refer to Figure 5-6. At the low frequency limit the voltage should measure -6 ±1V, and +2 ±1V at the high frequency limit. If these two measurements are within tolerance, no adjustments should be made. If one or both are out of tolerance adjust R37 and R35 respectively. (Note, earlier models were designed for -4 and +4V respectively. These are identifiable by the absence of CR5, 6, and 7 on the VCO board. Consult factory for calibration of such units.)

b. Connect counter to TP-3 and adjust R15 of IF OSC board for 106.0Hz for VF-1, or 3180Hz for VF-2.

c. Connect test set-up shown in Figure 5-5.

d. Set PAV-4 VRMS switch to .03, and REF LEVEL switch to .03 - 3V position.

e. Set test oscillator to 0.03 ±0.2%. Use 350Hz for VF-1, and 10KHz for VF-2.

f. Adjust REF LEVEL VERNIER for proper level on meter.

g. Set VF FREQUENCY dial to the maximum frequency limit, and set FUNCTION switch to FUND.

h. Connect oscilloscope to TP1, and adjust R12 for minimum square wave.

i. Turn R68 CCW slowly until LOCK lamp just turns on. Turn R68 CW approximately 3/4 of a turn. Lamp should go off.

j. Set VF FREQUENCY dial to same frequency as oscillator, and adjust R37 very slowly until LOCK lamp lights.

k. When LOCK indicator comes on, the meter should read approximately 30mv and the voltage at TP-4 should measure approximately -1V.

l. Connect oscilloscope to + end of C23, and adjust R53 for minimum square wave.

m. Adjust R43 for exactly +3.0 on meter.

n. Repeat l and m as required until both are satisfied.

o. Set test oscillator to highest plug-in frequency (10 KHz for VF-1 and 300KHz for VF-2).

p. Set VF FREQUENCY dial to same frequency as oscillator and adjust R35 very slowly until LOCK lamp lights.

q. Change test oscillator and VF to lowest plug-in frequency (300Hz for VF-1, and 10KHz for VF-2).

r. Adjust R37 very slowly until LOCK lamp lights.

s. Repeat steps o, p, q, and r as required, until dial is aligned at both ends.

5-23. Reference Channel Calibration

a. Connect test set-up shown in Figure 5-4.

b. Set test oscillator voltage to 0.1V ±0.2%. Set frequency to 1KHz for VF-1, and 30KHz for VF-2.

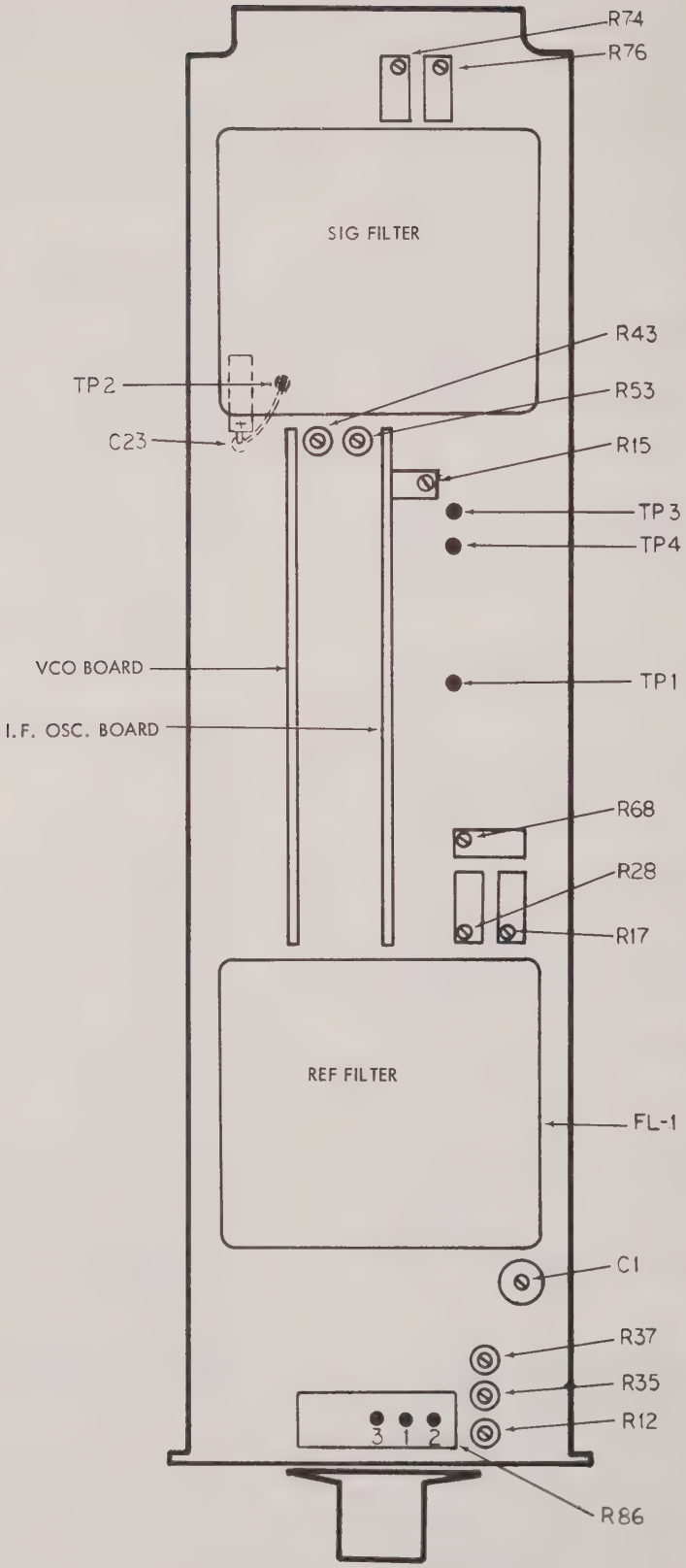


Figure 5-6. Calibration Test Point Locations, VF Module

c. Set PAV-4 FUNCTION switch to REF LEVEL.

d. Adjust REF LEVEL VARIABLE for REF LEVEL mark on meter.

e. Set PAV-4 FUNCTION switch to 0°. Adjust VF for LOCK.

f. Measure AC Voltage between A3-12 (0° Reference) and chassis, with AC Diff. VM on 1V range. Record reading.

CAUTION

ACCIDENTAL SHORTING OF A3-11 or A3-12 TO CHASSIS MAY CAUSE PERMANENT DAMAGE TO A3 BOARD.

g. Measure AC Voltage between A3-11 (180° Reference) and chassis, with AC Diff. VM on 1V range. Record reading.

h. Compute the average value obtained in steps f and g above.

i. With the AC Diff. VM on either A3-11 or 12, adjust A3R15 until voltage measured equals that computed in step h above. Voltage at A3-11 should now equal the voltage at A3-12 ±0.1%. Some minor readjustment may be necessary.

j. Measure AC Voltage between A2-22 (270° Reference) and chassis, with AC Diff. VM on 1V range.

k. Adjust integrating amplifier trimmer R76 on the VF mother board, if required until voltage at A2-22 equals that measured at A3-11 and 12 ±0.1%.

l. Measure AC Voltage between A2-15 (270° Reference) and chassis with AC Diff. VM on 1V range.

m. Adjust differentiator amplifier trimmer R74 on the VF mother board, if required until voltage at A2-15 equals that measured at A3-11 and 12 ±0.1%.

n. Measure AC Voltage between A2-11 (90° Reference) and chassis, with AC Diff. VM on 1V range.

o. Adjust A2R18 if required, until voltage at A2-11 equals that measured at A3-11 and 12 ±0.1%.

p. Remove Reference filter (FL2) from plug-in, and connect test oscillator directly to pin 5. Set oscillator voltage to 0.2 vrms ±1%, and set frequency to 106.0Hz for VF-1 or 3180Hz for VF-2. Set PHASING trimmer R28 on VF mother board to mid-range.

q. Vary test oscillator frequency ±5% from nominal, while monitoring the voltage at A2-11 with the AC Diff. VM on 1V range. Maintain a constant (±0.05%) test voltage over this frequency range. Adjust A2R10 if required, to maintain a constant voltage on the meter. Note, the best setting occurs when the voltage increases at both the + and -5% limit compared to the value at center frequency. Trimmer resolution may prevent equality at both limits.

r. Return oscillator to Reference input, and replace Reference filter. Set test voltage to 0.1V ±0.2%. Set frequency to 1KHz for VF-1, and 30KHz for VF-2. Adjust VF for LOCK, and recheck voltage at A3-11, A3-12, A2-22, A2-15, and A2-11 for equality. Readjust if required.

s. Measure 0V between A8-7 and chassis with DC VM. Voltage should measure 0 ±0.01V. Adjust A8R59 if required.

t. Adjust A8R21 for zero on meter.

u. Connect PAV-4 Signal input in parallel with Reference input, and set VRMS switch to 0.01. See Figure 5-5. Set FUNCTION switch to 90°.

v. Adjust PHASING trimmer, R28 for a null on the meter. Change oscillator frequency to VF lower limit, and adjust VF for LOCK. Note reading on meter. Change oscillator frequency to VF upper limit, and readjust VF for LOCK. Adjust C1 on VF mother board for a reading equal to that at the lower frequency limit. Recheck lower limit reading for equality. Readjust R28 for a null on meter.

w. Attach counter to TP-3 and adjust R15 on IF OSC board in order to vary IF oscillator frequency ±0.5% from nominal, while observing PAV-4 meter. It may be necessary to readjust the VF for LOCK. If meter deviation exceeds 0 ±2% of full scale (±0.2% of input) adjust TRACKING trimmer R17 on VF mother board for minimum deviation.

x. Return IF oscillator frequency to nominal, and readjust PHASING trimmer R28 for a null on the meter.

y. The VF plug-in used above and the main-frame reference channel are now calibrated.

5-24. Phase-Sensitive Signal Channel Calibration.

a. Change input test voltage to 31.6 MVRMS ±0.2%. Readjust REF LEVEL. Set frequency to 1KHz for VF-1, and 30KHz for VF-2.

b. Set PAV-4 VRMS switch to 0.03, and FUNCTION switch to 0°. Adjust VF for LOCK.

c. Adjust A8R36 for a reading of +3.16 on lower scale of meter. Note, this corresponds to a reading of +1.00 on the upper scale.

d. TOTAL, FUND, and 0^{o} should now all read the same (+3.16) on the PAV-4 meter. 90^{o} should read 0. Adjust A7R14, R43, A8R36, and R28 respectively, if required.

e. Measure +1V between pin 4 on TB-1 (rear panel) and chassis in 0^{o} mode with DC Diff. VM. Voltage should measure +1.0 ±0.005V. Adjust A8R65 if required.

f. Return to paragraph 5-18.

5-25. CALIBRATION FOR ADDITIONAL VF PLUG-INS.

5-26. Preliminary Adjustments.

a. With DC VM, measure the voltage from terminal No. 1 of R86 and chassis at both extremes of the dial. Refer to Figure 5-6. At the low frequency limit the voltage should measure -6 ±1V, and +2 ±1V at the high frequency limit. If these two measurements are within tolerance, no adjustments should be made. If one or both are out-of-spec, adjust R37 and R35 respectively. (Note, earlier models were designed for -4 and +4V respectively. These are identifiable by the absence of CR5, 6, and 7 on the VCO board. Consult factory for calibration of such unit.)

b. Connect counter to TP-3 and adjust R15 of IF OSC board for 106.0Hz for VF-1, or 3180Hz for VF-2.

c. Connect test set-up shown in Figure 5-5.

d. Set PAV-4 VRMS switch to .03, and REF LEVEL switch to .03 - 3V position.

e. Set test oscillator to 0.03 ±0.2%. Use 350Hz for VF-1, and 10KHz for VF-2.

f. Adjust REF LEVEL VERNIER for proper level on meter.

g. Set VF FREQUENCY dial to the maximum frequency limit, and set FUNCTION switch to FUND.

h. Connect oscilloscope to TP1, and adjust R12 for minimum square wave.

i. Turn R68 CCW slowly until LOCK lamp just turns on. Turn R68 CW approximately 3/4 of a turn. Lamp should go off.

j. Set VF FREQUENCY dial to same frequency as oscillator, and adjust R37 very slowly until LOCK lamp lights.

k. When LOCK indicator comes on, the meter should read approximately 30mv and the voltage at TP4 should measure approximately -1V.

l. Connect oscilloscope to + end of C23, and adjust R53 for a minimum square wave.

m. Adjust R43 for exactly +3.0 on meter.

n. Repeat l and m as required, until both are satisfied.

o. Set test oscillator to highest plug-in frequency (10KHz for VF-1, and 300KHz for VF-2).

p. Set VF FREQUENCY dial to same frequency as oscillator, and adjust R35 very slowly until LOCK lamp lights.

q. Change test oscillator and VF to lowest plug-in frequency (300Hz for VF-1, and 10KHz for VF-2).

r. Adjust R37 very slowly until LOCK lamp lights.

s. Repeat steps o, p, q, and r as required until dial is aligned at both ends.

5-27. Reference Channel Calibration

a. Connect test set-up shown in Figure 5-4.

b. Set test oscillator voltage to 0.1V ±0.2%. Set frequency to 1KHz for VF-1, and 30KHz for VF-2.

c. Set PAV-4 FUNCTION switch to REF LEVEL.

d. Adjust REF LEVEL VARIABLE for REF LEVEL mark on meter.

e. Set PAV-4 FUNCTION switch to 0^{o}. Adjust VF for LOCK.

f. Measure AC Voltage between A3-12 (0^{o} Reference) and chassis, with AC Diff. VM on 1V range. Record reading.

CAUTION

ACCIDENTAL SHORTING OF A3-11 OR A3-12 TO CHASSIS MAY CAUSE PERMANENT DAMAGE TO THE A3 BOARD.

g. Measure AC Voltage between A2-22 (270^{o} Reference) and chassis, with AC Diff. VM on 1V range.

h. Adjust integrating amplifier trimmer R76 on the VF mother board, if required, until voltage at A2-22 equals that measured at A3-12 ±0.1%.

i. Measure AC Voltage between A2-15 (270° Reference) and chassis, with AC Diff. VM on 1V range.

j. Adjust differentiator amplifier trimmer R74 on the VF mother board, if required, until voltage at A2-15 equals that measured at A3-12 ±0.1%.

k. Measure AC Voltage between A2-11 (90° Reference) and chassis, with AC Diff. VM on 1V range.

l. Adjust A2R18 if required, until voltage at A2-11 equals that measured at A3-12 ±0.1%.

m. Connect PAV-4 Signal input in parallel with Reference input, and set VRMS switch to 0.01. See Figure 5-5. Set FUNCTION switch to 90°.

n. Adjust PHASING trimmer R28 for a null on the meter. Change oscillator frequency to VF lower limit, and adjust VF for LOCK. Note reading on meter. Change oscillator frequency to VF upper limit, and readjust VF for LOCK. Adjust C1 on VF mother board for a reading equal to that at the lower frequency limit. Recheck lower limit reading for equality. Readjust R28 for a null on meter.

o. Attach counter to TP3 and adjust R15 on IF OSC board in order to vary IF oscillator frequency ±0.5% from nominal, while observing PAV-4 meter. It may be necessary to readjust the VF for LOCK. If meter deviation exceeds ±2% of full scale (±0.2% of input) adjust TRACKING trimmer R17 on VF mother board for a minimum deviation.

p. Return IF oscillator frequency to nominal, and readjust PHASING trimmer R28 for a null on the meter.

q. The VF plug-in used above is now calibrated. Return to paragraph 5-18.

5-28. CALIBRATION FOR ADDITIONAL FIXED-FREQUENCY PLUG-INS.

5-29. FUNDAMENTAL Calibration

a. Connect test set-up shown in Figure 5-3.

b. Set plug-in and test oscillator to the nominal (center) operating frequency ±0.1%.

c. Set PAV-4 FUNCTION switch to FUND.

d. Change input test voltage to 0.03V ±0.2%. Set PAV-4 VOLTS-RMS switch to 0.03.

e. Adjust FUND. trimmer R1, on the frequency network board in the plug-in, if required to read exactly +3.0 on the meter.

5-30. Reference Channel Calibration.

a. Connect test set-up shown in Figure 5-4.

b. Set test oscillator voltage to 0.1V ±.2%. Frequency must be maintained at nominal ±0.1%.

c. Set PAV FUNCTION switch to REF LEVEL.

d. Adjust REF LEVEL VARIABLE for REF LEVEL mark on meter.

e. Set PAV-4 FUNCTION switch to 0°.

f. Measure AC Voltage between A3-12 (0° Reference) and chassis, with AC Diff. VM on 1V range. Record reading.

CAUTION

ACCIDENTAL SHORTING OF A3-11 OR A3-12 MAY CAUSE PERMANENT DAMAGE TO THE A3 BOARD.

g. Measure AC Voltage between A2-22 (270° Reference) and chassis, with AC Diff. VM on 1V range.

h. Adjust integrating amplifier trimmer R10 on the frequency network board, if required until voltage at A2-22 equals that measured at A3-12 ±0.1%.

i. Measure AC Voltage between A2-15 (270° Reference) and chassis with AC Diff. VM on 1V range .

j. Adjust differentiator amplifier trimmer R7 on the frequency network board, if required, until voltage at A2-15 equals that measured at A3-12 ±0.1%.

k. Measure AC Voltage between A2-11 (90° Reference) and chassis, with AC Diff. VM on 1V range.

l. Adjust A2R18 if required, until voltage at A2-11 equals that measured at A3-12 ±0.1%.

m. Connect PAV-4 Signal input in parallel with Reference input, and set VRMS switch to 0.01. See Figure 5-5. Set FUNCTION switch to 90°.

n. Adjust PHASING trimmer R5 for a null on the meter.

o. Vary test oscillator frequency ±5% from nominal, while observing PAV-4 meter. If meter deviation exceeds ±2% of full scale (±0.2% of input) adjust TRACKING trimmer R3 on frequency network board for minimum deviation.

p. Return test oscillator frequency to nominal, and readjust PHASING trimmer R5 for a null on the meter.

q. The fixed-frequency used above is now calibrated. Return to paragraph 5-18.

5-31. INPUT ATTENUATOR CALIBRATION FOR UNITS ABOVE 3KHz ONLY.

a. Set test oscillator to 3VRMS ±0.2% at 10KHz.

b. Set FUNCTION switch to TOTAL, and VRMS switch to 3.

c. Adjust A6C2 for +3.0 on meter.

d. Change frequency to 300KHz, and readjust A6R4 if required to read exactly +3.0 on meter.

e. Change frequency back to 10KHz and readjust A6C2 if required for exactly +3.0 on meter. Reset frequency to 300Hz.

f. Set REF LEVEL switch to 3-300V position, FUNCTION switch to REF LEVEL, and adjust VARIABLE for REF LEVEL mark on meter.

g. Change the frequency to 10KHz, and adjust A4C1 for same reading as (f) above.

h. Select the plug-in with the highest operating frequency, and install it in the PAV-4 to be calibrated. Set the plug-in to the highest operating frequency.

i. Set test oscillator to nominal operating frequency. Use 300KHz for VF-2.

j. With REF LEVEL switch in 0.03 - 3V position, adjust variable for proper level on meter. Set VRMS switch to 0.3.

k. Set FUNCTION switch to 90°. Lock VF if used.

l. Adjust A6R5 for a null on the meter. If A6R5 will not null, some compromise may be necessary with the setting of A6C2 in (e) above.

m. Set REF LEVEL switch to 3 - 300V position, and readjust VARIABLE for proper level on meter.

n. Set FUNCTION switch to 90°.

o. Adjust A4R3 for a null on the meter. If A4R3 will not null, readjust A4C1.

p. The PAV-4 main-frame and all the plug-ins are now completely calibrated, except for phase sensitive operation below 3KHz.

5-32. INPUT ATTENUATOR CALIBRATION FOR UNITS BELOW 3KHz ONLY.

a. Select the plug-in with the lowest operating frequency and install it in the PAV-4 to be calibrated. Set the plug-in to the lowest operating frequency.

b. Set test oscillator to nominal operating frequency. Use 350Hz for VF-1.

c. Set input test voltage to 3VRMS ±.2%, and FUNCTION switch to REF LEVEL.

d. With REF LEVEL switch in 0.03 - 3V position, adjust VARIABLE for proper level on meter.

e. Set PAV-4 VRMS switch to 0.3, and FUNCTION switch to 90°. Lock VF-1, if used.

f. Adjust A6C2 for a null on the meter.

g. Set VRMS switch to 3.0, and set FUNCTION switch to TOTAL.

h. Set test oscillator to 300Hz.

i. Readjust A6R4 if required, to read exactly +3.0 on meter.

j. Return oscillator frequency to nominal value in step b above, and VRMS switch to 0.3.

k. Set REF LEVEL switch to 3 - 300V position, and readjust VARIABLE for proper level on meter.

l. Set FUNCTION switch to 90°.

m. Adjust A4C1 for a null on the meter.

n. Set FUNCTION switch to TOTAL, and VRMS switch to 3.0.

o. Set oscillator to 3 VRMS ±0.2% at 300KHz.

p. Adjust A6R5 for a reading of exactly +2.9 on meter. (Same as 5-11g.)

q. It is not necessary to calibrate A4R3.

r. The PAV-4 mainframe and all the plug-ins are now completely calibrated, except for phase sensitive operation above 3KHz.

SECTION VI

PARTS LIST

6-1. GENERAL.

6-2. This section lists and describes the electronic parts for the Model PAV-4A and PAV-4B main frames. The parts of the plug-in modules are listed in subsequent sections.

6-3. Many parts of the equipment are standard electronic parts, procurable from a number of sources. Standard type designations are used to describe these parts and, in most cases, a primary manufacturer is listed.

6-4. Manufacturer codes used in this parts list are as procurable from a number of sources

VENDOR CODE	VENDOR NAME AND ADDRESS
00327	Welwyn International, Incorporated Cleveland, Ohio
01121	Allen Bradley Milwaukee, Wisconsin
01295	Texas Instruments, Incorporated Dallas, Texas
02101	Varo, Incorporated Santa Barbara, California
02660	Amphenol–Borg Electronics Corporation Broadview, Chicago, Illinois
03508	GECO Semiconductor Products Division Syracuse, New York
03614	Bussman Fuse Los Angeles, California
04213	Caddel-Burns Mfg. Company, Incorporated Mineola, New York
04387	Dale Electronics, Incorporated Burbank, California
04713	Motorola, Incorporated Phoenix, Arizona
05574	Viking Industries, Incorporated Canoga, Park, California
11452	Jan Engineering Santa Monica, Califonia
12406	Elpac. Incorporated Fullerton, California
15450	Erie Resistor Corporation Erie, Pennsylvania
17856	Siliconix, Incorporated Sunnyvale, California
58474	Superior Electric Company Bristol, Connecticut
70903	Belden Manufacturing Company Chicago, Illinois

VENDOR CODE	VENDOR NAME AND ADDRESS
71450	CTS Corporation Elkhart, Indiana
71785	Cinch Manufacturing Company Chicago, Illinois
72136	Electro-Motive Manufacturing Company Williamantic, Connecticut
73445	Amperex Electronic Company Hicksville, New York
76433	General Instrument Corporation Capacitor Group Newark, New Jersey
79089	RCA Harrison, New Jersey
82389	Switchcraft, Incorporated Chicago, Illinois
91293	Johanson Manufacturing Company Boonton, New Jersey
95354	Methode Manufacturing Company Chicago, Illinois
X0001	Mura Corporation
X0002	Colvern, Ltd. Romford, Great Britain

PHASE ANGLE VOLTMETER (See Figure 6-1)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG. PART NO.	PAV-4A	PAV-4B
A1	10^{O} Phase Shift Switch (see figure 6-2 for details)	4-002787-001	88869		A	B
A2	Quadrature Circuit Board (see figure 6-3 for details)	5-002769-001	88869		A	B
A3	Quadrature X5 Circuit Board (see figure 6-4 for details)	4-002770-001	88869		A	B
A4	Reference Input Circuit Board (see figure 6-5 for details)	4-002700-001	88869		A	
A4	Reference Input, Circuit Board (see figure 6-5 for details)	4-003017-001	88869			B
A5	Power supply Circuit Board (see (figure 6-6 for details)	5-002771-001	88869		A	B
A6	Signal Input Circuit Board (see figure 6-7 for details)	4-002699-001	88869		A	
A6	Signal Input Circuit Board (see figure 6-7 for details)	4-003016-001	88869			B
A7	X1, X30 Circuit Board (see figure 6-8 for details)	5-002767-001	88869		A	B
A8	Detector Circuit Board (see figure 6-9 for details)	5-002768-001	88869		A	B
A9	Reference X5 Circuit Board (see figure 6-10 for details)	4-002806-001	88869		A	B
A10	Isolated Input Circuit Board (see figure 6-11 for details)	4-002843-002	88869			B
A11	Isolated Inverter Circuit Board (see figure 6-12 for details)	4-002844-002	88869			B
A12	Isolated Input Circuit Board (see figure 6-11 for details)	4-002843-001	88869			B
A13	Isolated Inverter Circuit Board (see figure 6-12 for details)	4-002844-001	88869			B
C1	Not Used					
C2	Capacitor, plastic, .1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE	A	B
DS1	Light Indicator, Red	1-925007-003	X00001	L10/20	A	B
DS2	Light Indicator, White	1-925007-005	X00001	L10/20	A	B
DS3	Light Indicator, Amber	1-925007-001	X00001	L10/20	A	B
E1						

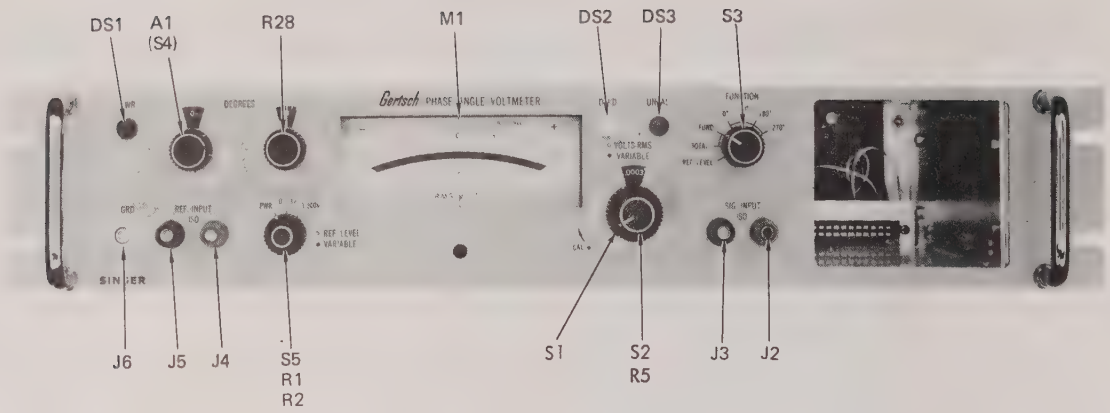


Figure 6-1a. PAV-4, Front View

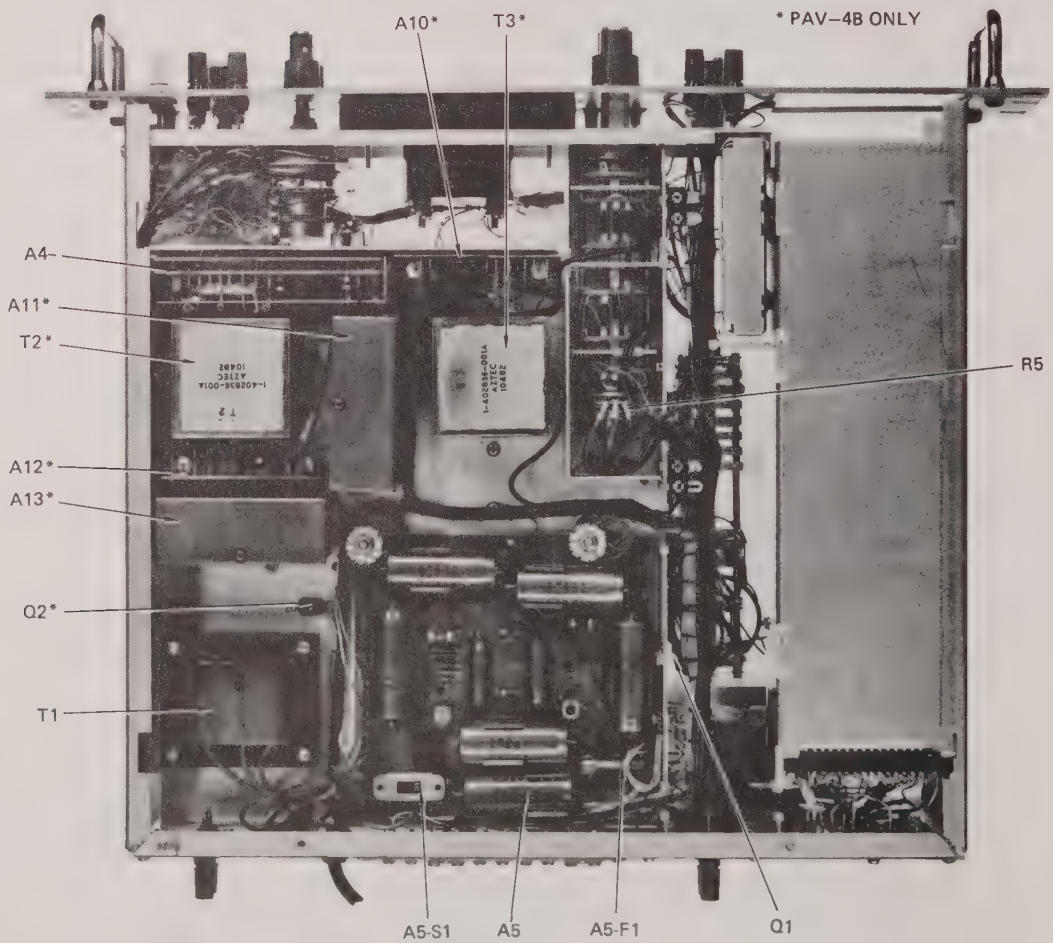


Figure 6-1b. PAV-4, Bottom View

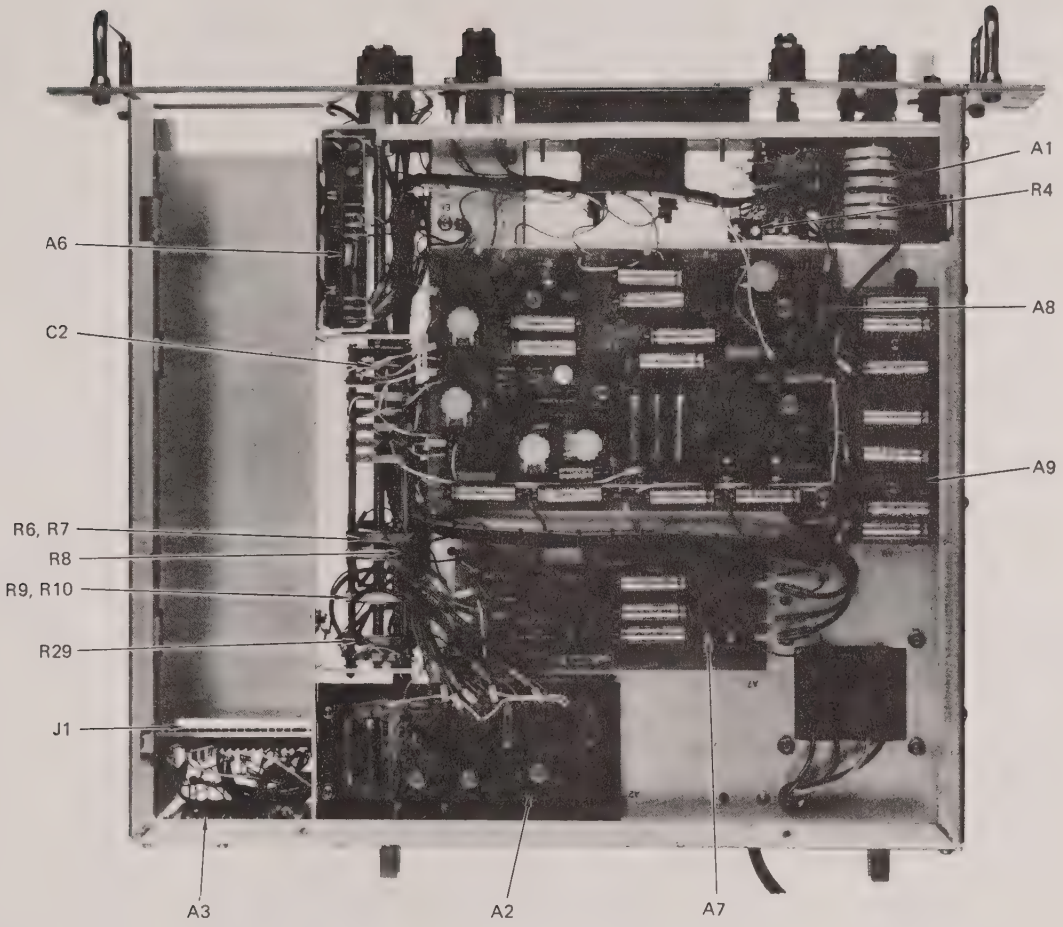


Figure 6-1c. PAV-4, Top View

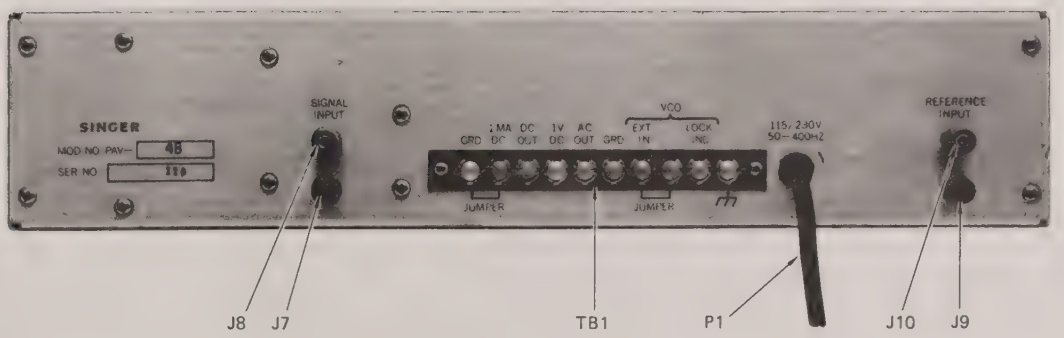
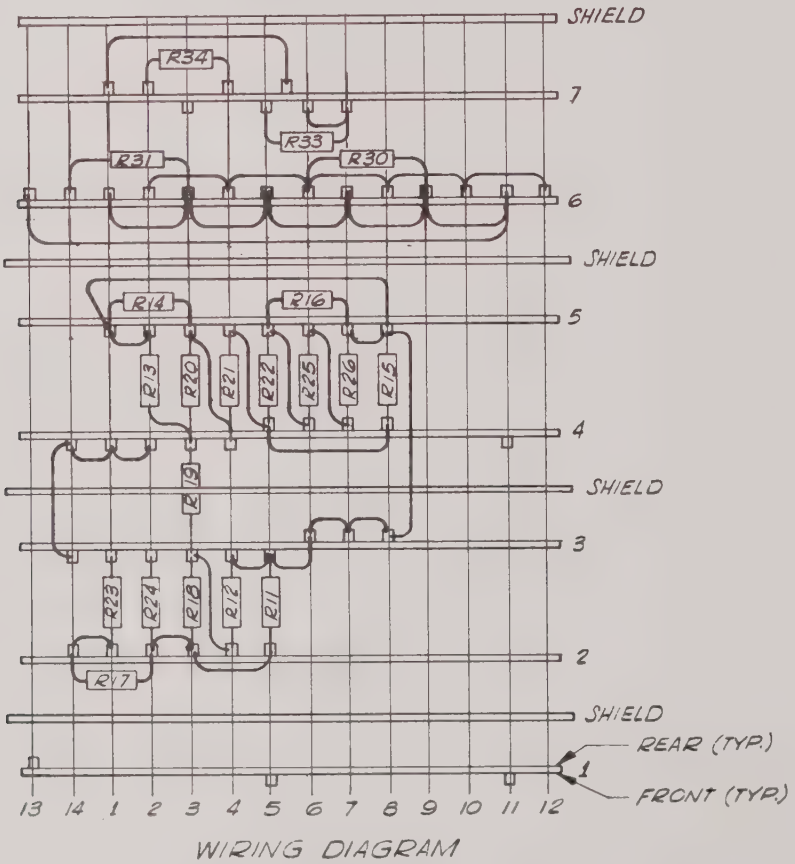


Figure 6-1d. PAV-4, Rear View

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
E2	Stud, grounding	1-945145-001	11452	1001	A	B
E3						
E4	Link, Shorting	1-964140-001	71785	5 - 101	A	B
J1	Connector, Circuit Board	1-910082-003	05574	2VK15D1 - 1	A	B
J2	Binding Post, Red	1-941018-001	58474	DF21RC	A	B
J3	Binding Post, Black	1-941018-003	58474	DV21BC	A	B
J4	Binding Post, Red	1-941018-001	58474	DF21RC	A	B
J5	Binding Post, Black	1-941018-003	58474	DV21BC	A	B
J6	Binding Post, White	1-941018-002	58474	DF21WTC	A	B
J7	Binding Post, Black	1-941018-003	58474	DV21BC	A	B
J8	Binding Post, Red	1-941018-001	58474	DF21RC	A	B
J9	Binding Post, Black	1-941018-003	58474	DV21BC	A	B
J10	Binding Post, Red	1-941018-001	58474	DF21RC	A	B
M1	Meter, 1-0-1 ma	3-402817-001	88869		A	B
P1	Power Cord	1-910011-001	70903	17238B	A	B
Q1	Transistor, NPN	1-958001-002	04713	MJE520	A	B
Q2	Transistor, PNP	1-958001-001	04713	MJE370	A	B
R1	Resistor, variable, 1K ±10% (P/OS5)	4-402819-099	88869		A	B
R2	Resistor, variable, 1K ±10% (P/OS5)	4-402819-099	88869		A	B
R3	Resistor, comp, 820 ohms ± 10%, 1/4W	1-945000-036	01121	Type CB	A	B
R4	Resistor, comp, 2.7 ohms ±10%, 1/4W	1-945000-006	01121	Type CB	A	B
R5	Resistor, variable, 1K ±10% (P/OS1)	2-402868-001	88869		A	B
R6	Resistor, film, 1210 ohms ±1%, 1/4W	1-945016-201		Type RN60D	A	B
R7	Resistor, film, 10K ± 1%, 1/4W	1-945016-289		Type RN60D	A	B
R8	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B
R9	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B

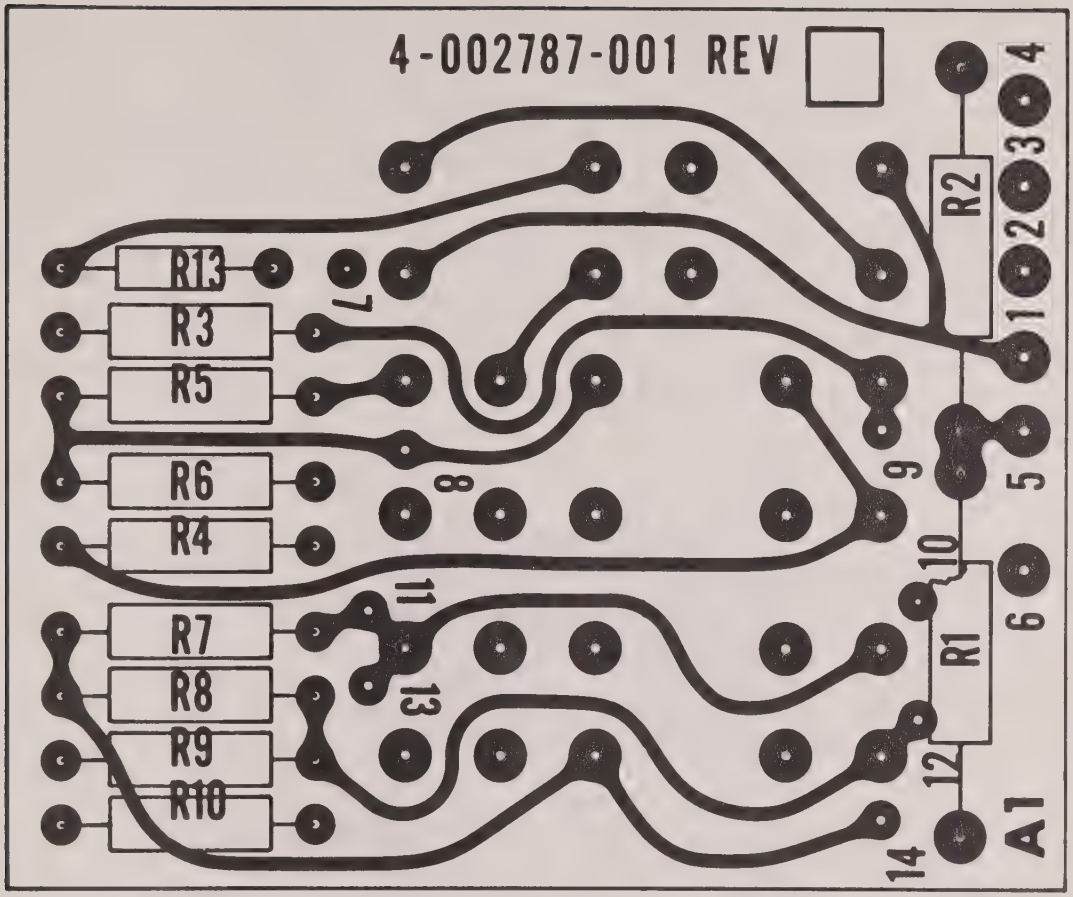
REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R10	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R11	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R12	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R13	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R14	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R15	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R16	Resistor, film, 460.6 ohms ±1/4%, 1/4W	1-945043-002	04387	Type MF1/8T1	A	B
R17	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R18	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R19	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R20	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R21	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R22	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R23	Resistor, comp, 220 ohms ±10%, 1/4W	1-945000-029	01121	Type CB	A	B
R24	Resistor, comp, 22 ohms ±10%, 1/4W	1-945000-017	01121	Type CB	A	B
R25	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R26	Resistor, film, 314.9 ohms ±1/4%, 1/4W	1-945043-001	04387	Type MF1/8T1	A	B
R27	Resistor, comp, 330 ohms ±10%, 1/4W	1-945000-031	01121	Type CB	A	B
R28	Resistor, variable, 500 ohms ±5%	2-402855-001	88869		A	B
R29	Resistor, comp, 2.7K ±10%, 1/4W	1-945000-042	01121	Type CB	A	B
R30	Resistor, film, 681 ohms ±1/4%, 1/4W	1-945043-003	04387	Type MF1/8T1	A	B
R31	Resistor, film, 314.9 ohms ±1/4%, 1/4W	1-945043-001	04387	Type MF1/8T1	A	B
R32	Selected Value				A	B
R33 (S/N 401 up only)	Resistor, film, 2.55K ±1%	1-945016-232		RN 60D	A	B
R34 (S/N 401 up only)	Resistor, film, 1K ±1%	1-945016-193		RN 60D	A	B
S1	Switch, volts-RMS	3-402850-001	88869		A	B
S2	Switch, UNCAL (P/O R5)	3-402850-001	88869		A	B
S3	Switch, FUNCTION	4-402822-099	88869		A	B
S4	Switch, 10° Phase Shift (P/O A1)				A	B
S5	Switch, REF LEVEL	4-402819-099	88869		A	B
T1	Transformer, power	1-402834-001	88869		A	B

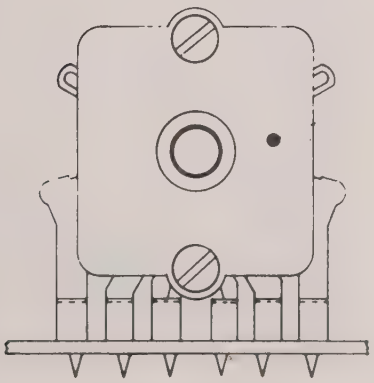
REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
T2	Transformer, isolation, Ref	1-402836-001	88869			B
T2 PAV-4C ONLY	Transformer, isolation, Ref	1-402836-003	88869			
T3 PAV-4C ONLY	Transformer, isolation, Ref	1-402836-004	88869			
T3	Transformer, isolation, Signal	1-402836-002	88869			B
TB1	Terminal Board	1-941019-001	71785	321-1102-013	A	B



WIRING DIAGRAM

Figure 6-1e. Parts Location, Volts RMS Switch



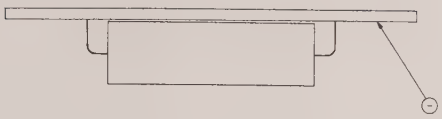


FRONT VIEW
NO SCALE

Figure 6-2. Switch Assembly – Phase Shift 10°, A1

10^{o} PHASE SHIFT SWITCH A1 (See Figure 6-2)

REF DESIG	DESCRIPTION	SINGER MFG NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R1	Resistor, film, 7.721K ±1%, 1/4W	1-945016-581		Type RN60D	A	B
R2	Resistor, film, 7.721K ±1%, 1/4W	1-945016-581		Type RN60D	A	B
R3	Resistor, ww, non-inductive, 475 ohms ±0.05%, 1/8W	1-945040-001	04387	Type WWA13	A	B
R4	Resistor, ww, non-inductive, 1.9K ±0.05%, 1/8W	1-945040-003	04387	Type WWA13	A	B
R5	Resistor, ww, non-inductive, 475 ohms ±0.05%, 1/8W	1-945040-001	04387	Type WWA13	A	B
R6	Resistor, ww, non-inductive, 950 ohms ±0.05%, 1/8W	1-945040-002	04387	Type WWA13	A	B
R7	Resistor, ww, non-inductive, 950 ohms ±0.05%, 1/8W	1-945040-002	04387	Type WWA13	A	B
R8	Resistor, ww, non-inductive, 475 ohms ±0.05%, 1/8W	1-945040-001	04387	Type WWA13	A	B
R9	Resistor, ww, non-inductive, 1.9K ±0.05%, 1/8W	1-945040-002	04387	Type WWA13	A	B
R10	Resistor, ww, non-inductive, 475 ohms ±0.05%, 1/8W	1-945040-001	04387	Type WWA13	A	B
R11	Resistor, selected value				A	B
R12	*Resistor, selected value				A	B
R13	Resistor, comp, 2.7K ±10%, 1/4W	1-945000-042	01121	Type CB	A	B
S1	Switch, degree (not shown)	4-402863-001	88869		A	B



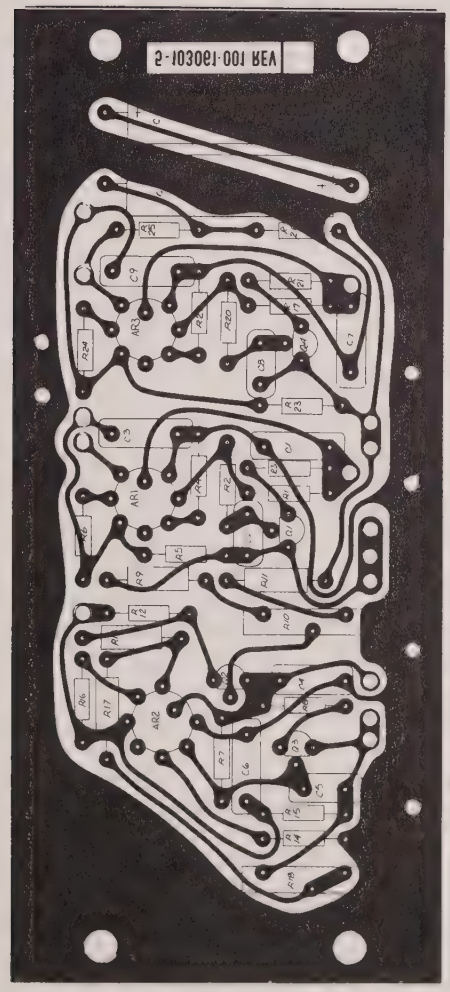


Figure 6-3. Quadrature Circuit Board Assembly, A2

QUADRATURE CIRCUIT BOARD A2 (See Figure 6-3)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
AR1	IC, Diff. cascade amp.	1-926005-001	79089	CA3028	A	B
AR2	IC, Diff. cascade amp.	1-926005-001	79089	CA3028	A	B
AR3	IC, Diff. cascade amp.	1-926005-001	79089	CA3028	A	B
C1	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C2	Capacitor, mica, 150pf ±5%, 500 vdcw	1-900003-034	72136	DM15F151J	A	B
C3	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C4	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C5	Capacitor, mica, 22pf ±5%, 500 vdcw	1-900003-013	72136	DM15E220J	A	B
C6	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C7	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C8	Capacitor, mica, 22pf ±5%, 500 vdcw	1-900003-013	72136	DM15E220J	A	B
C9	Capacitor, plastic, 0.1uf ±20%, 250 vdcw	1-900001-013	73445	Type C280AE	A	B
C10	Capacitor, electrolytic, 200uf, 15 vdcw	1-900039-002	76433	974-141	A	B
C11	Capacitor, electrolytic, 200uf, 15 vdcw	1-900039-002	76433	974-141	A	B
Q1	Transistor	1-958000-001	04713	2N3906	A	B
Q2	Transistor	1-958000-001	04713	2N3904	A	B
Q3	Transistor	1-958000-002	04713	2N3906	A	B
Q4	Transistor	1-958000-002	04713	2N3906	A	B
R1	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R2	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B

QUADRATURE CIRCUIT BOARD A2 (Continued)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R3	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R4	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B
R5	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R6	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R7	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R8	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R9	Resistor, film, 4.99K ±1%, 1/4W	1-945016-260		Type RN60D	A	B
R10	Resistor, variable, 10K	1-945039-010	02660	3800 P103	A	B
R11	Resistor, film, 4.99K ±1%, 1/4W	1-945016-260		Type RN60D	A	B
R12	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R13	Resistor, film, 10K ±1%, 1/4W	1-945016-289		Type RN60D	A	B
R14	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R15	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R16	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R17	Resistor, film, 9.53K ±1%, 1/4W	1-945016-287		Type RN60D	A	B
R18	Resistor, variable, 1K	1-945039-007	02660	3800 P102	A	B
R19	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R20	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R21	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B
R22	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R23	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R24	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R25	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B
R26	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B

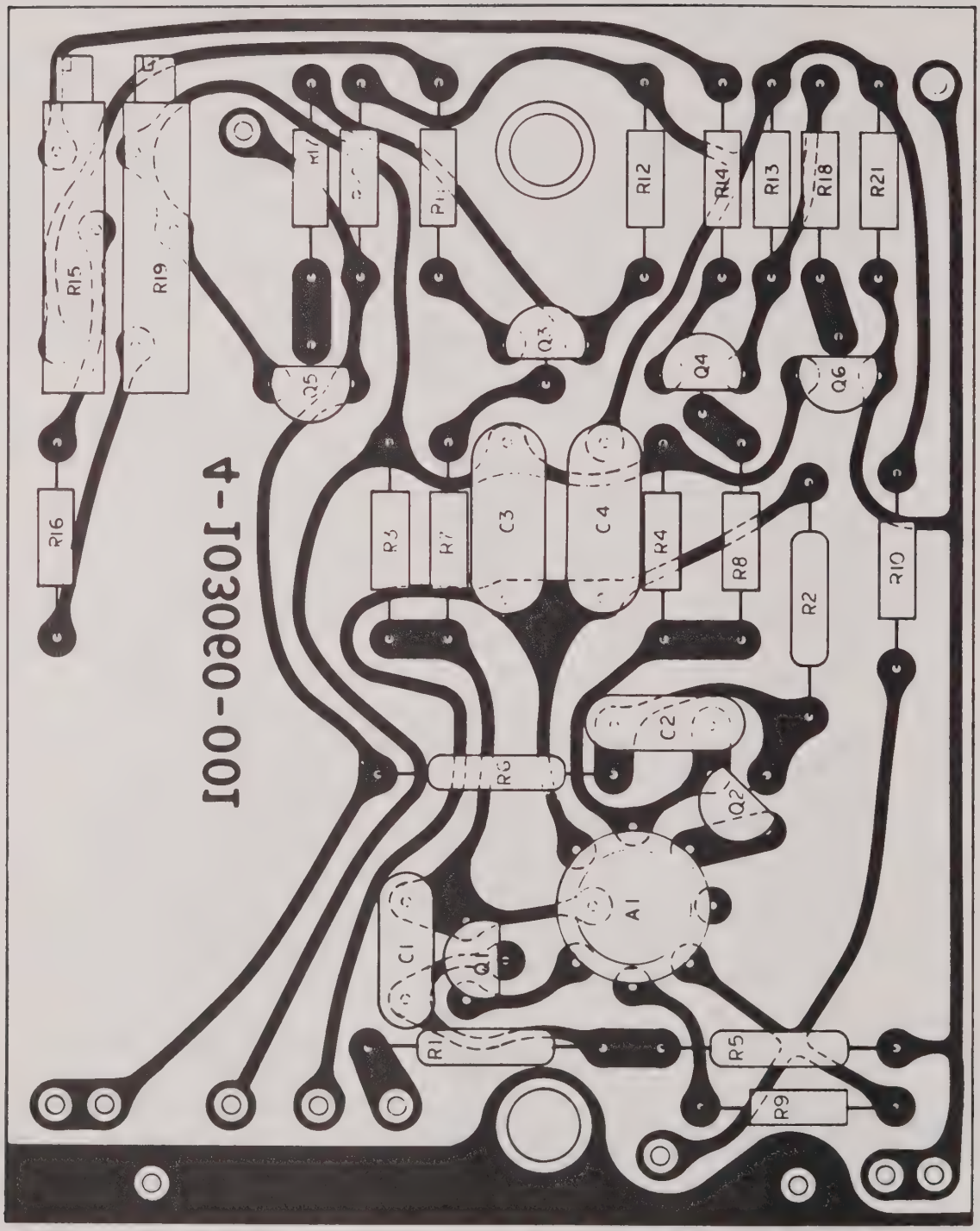


Figure 6-4. Circuit Board Assembly, Quad, X5, A3

QUADRATURE X5 CIRCUIT BOARD A3 (See Figure 6-4)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
AR1	IC, Diff. cascade amp.	1-926005-001	79089	CA 3028	A	B
C1	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C2	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C3	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C4	Capacitor, plastic, 0.1uf ±20% 250vdcw	1-900001-013	73445	Type C280AE	A	B
Q1	Transistor	1-958000-001	04713	2N3904	A	B
Q2	Transistor	1-958000-001	04713	2N3904	A	B
Q3	Transistor	1-958000-002	04713	2N3906	A	B
Q4	Transistor	1-958000-002	04713	2N3906	A	B
Q5	Transistor	1-958000-001	04713	2N3904	A	B
Q6	Transistor	1-958000-001	04713	2N3904	A	B
R1	Resistor, film, 10K ±1%, 1/4W	1-945016-289		Type RN60D	A	B
R2	Resistor, film, 20K ±1%, 1/4W	1-945016-318		Type RN60D	A	B
R3	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R4	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R5	Resistor, film, 200K ±1%, 1/4W	1-945016-414		Type RN60D	A	B
R6	Resistor, film, 200K ±1%, 1/4W	1-945016-414		Type RN60D	A	B
R7	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R8	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R9	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R10	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R11	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B
R12	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R13	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R14	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B
R15	Resistor, variable, 100 ohms	1-945039-004	02660	3800 P101	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R16	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R17	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R18	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R19	Resistor, variable, 500 ohms	1-945039-006	02660	3800 P501	A	B
R20	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R21	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B

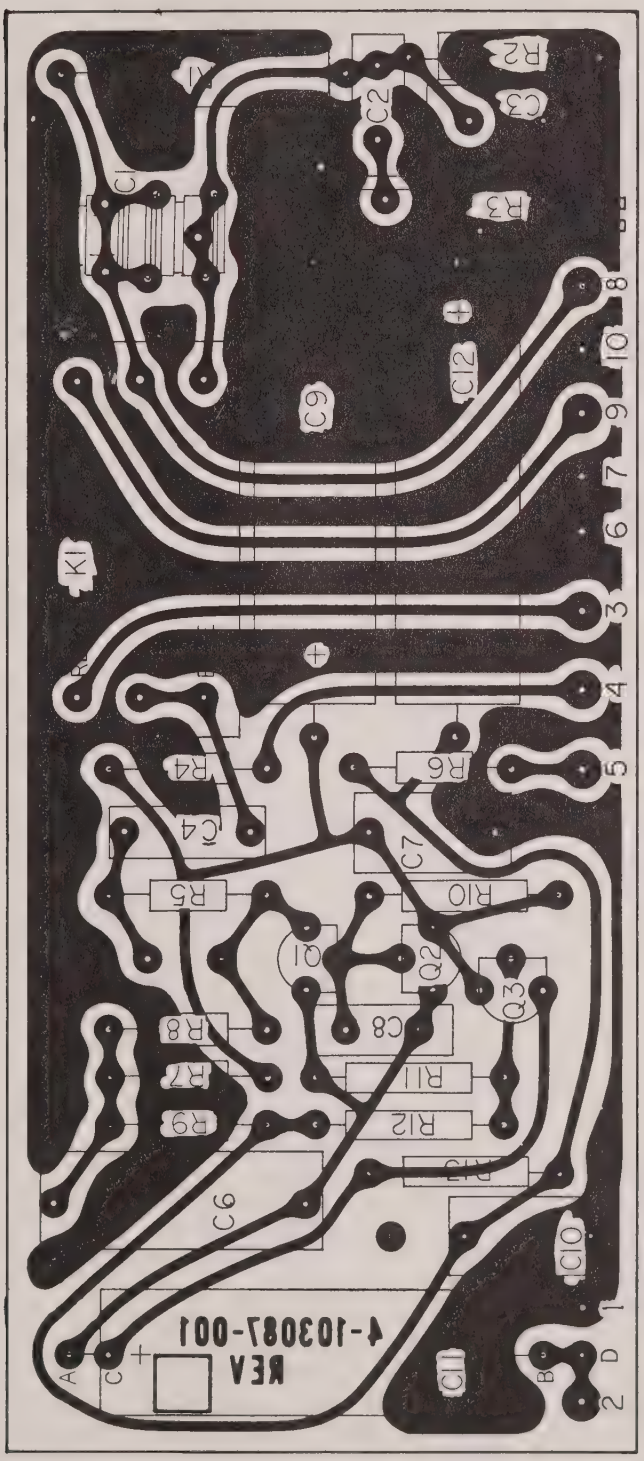


Figure 6-5a. Circuit Board Assembly, Ref Input, A4, PAV-4A

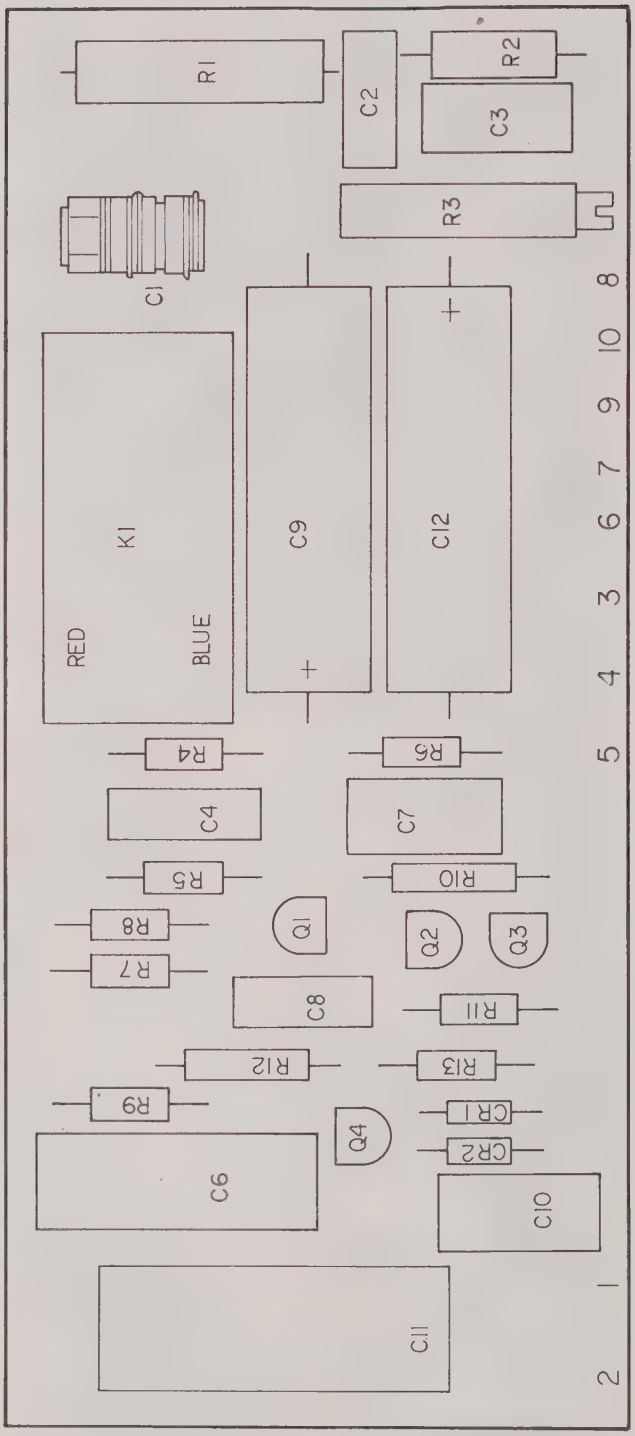


Figure 6-5b. Circuit Board Assembly, Ref Input, A4, PAV-4B

REFERENCE INPUT CIRCUIT BOARD A4 (See Figure 6-5)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C1	Capacitor, variable, 1.5 - 10pf	1-900064-001	91293	7331	A	B
C2	Capacitor, mica, 300pf ±5%, 500vdcw	1-900003-042	72136	DM15E301J	A	B
C3	Capacitor, mica, 470pf ±5%, 500vdcw	1-900003-047	72136	DM15F471J	A	B
C4	Capacitor, plastic, 0.01uf ±20%, 250vdcw	1-900001-001	73445	Type C280AE	A	B
C5	Not used	–	–	–	–	–
C6	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C7	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C8	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
C9	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C10	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C11	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974 - 141	A	B
C12	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974 - 141	A	B
CR1	Diode, Silicon	1-913007-001	03508	1N4148	–	B
CR2	Diode, Silicon	1-913007-001	03508	1N4148	–	B
K1	Relay, Reed	1-402791-001	88869	–	A	–
Q1	Transistor, FET	1-958031-003		–	A	–
Q2	Transistor, PNP	1-958000-002	04713	2N3906	A	B
Q3	Transistor, NPN	1-958000-001	04713	2N3904	A	–
Q4	Transistor, NPN	1-958000-002	04713	2N3906		B
R1	Resistor, film, 10 meg ±1%, 1/2W	1-945044-577	00327	Type M12	A	B
R2	Resistor, film, 100K ±1%, 1/4W	1-945016-385	–	Type RN60D	A	B
R3	Resistor, variable, 2K	1-945039-008	02660	3800 P202	A	B
R4	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R5	Resistor, comp, 39K ±10%, 1/4W	1-945000-056	01121	Type CB	A	B
R6	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R7	Resistor, comp, 470K ±10%, 1/4W	1-945000-069	01121	Type CB	A	–
	Resistor, comp, 1M ±10%, 1/4W	1-945000-073	01121	Type CB	–	B
R8	Resistor, comp, 3.3 meg ±10%, 1/4W	1-945000-079	01121	Type CB	A	B
R9	Resistor, comp, 1M ±10%, 1/4W	1-945000-073	01121	Type CB	A	–
	Resistor, comp, 1.2M ±10%, 1/4W	1-945000-074	01121	Type CB	–	B
R10	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R11	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	–
	Resistor, comp, 22 ohms ±1%, 1/4W	1-945000-017			–	B
R12	Resistor, film, 332 ohms ±1%, 1/4W	1-945016-147		Type RN60D	A	–
	Resistor, film, 10K ±1%, 1/4W	1-945016-289		Type RN60D	–	B
R13	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	–
	Resistor, comp, 22 ohms ±1%, 1/4W	1-945000-017			–	B

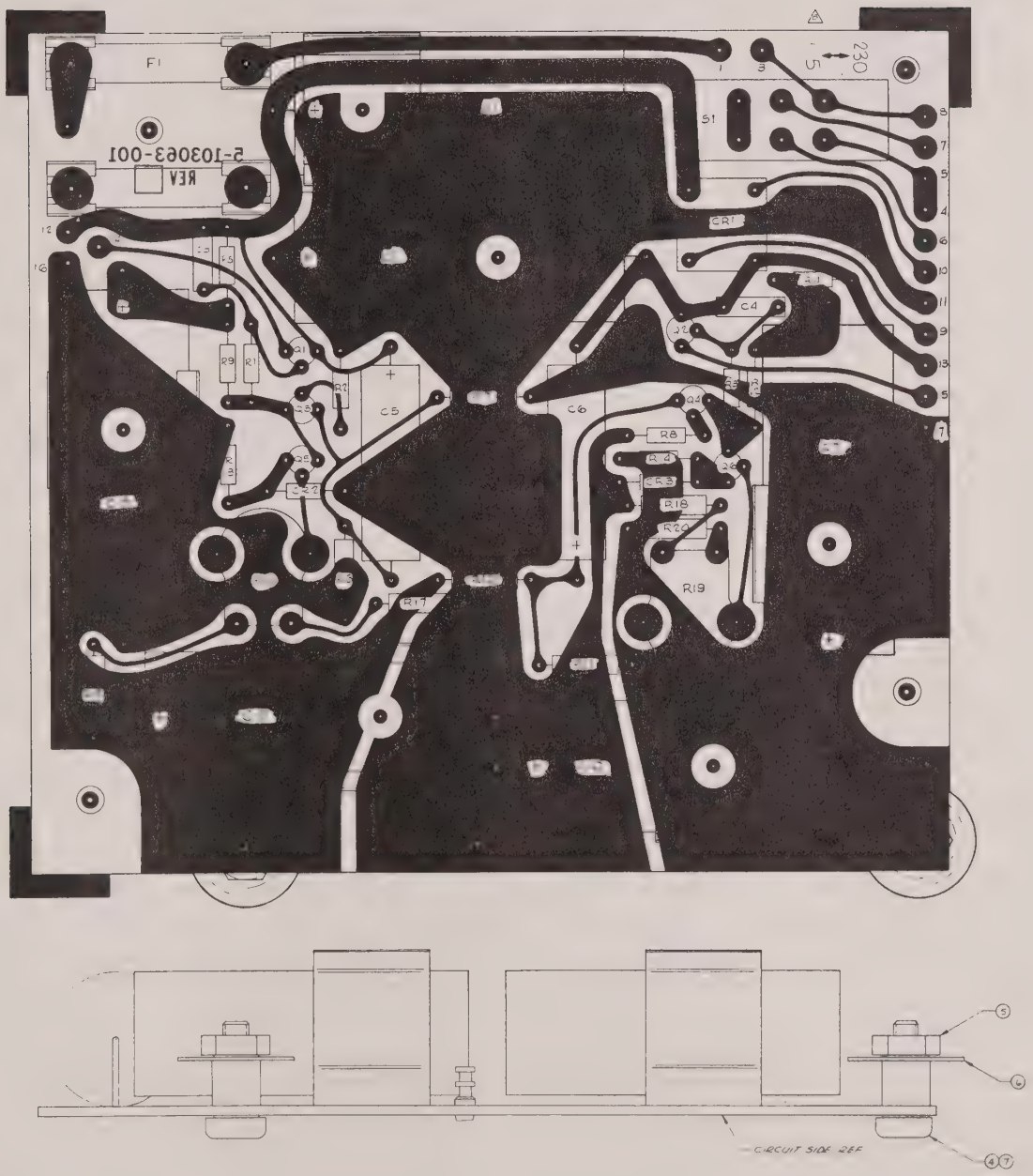


Figure 6-6. Circuit Board Assembly, Power Supply

POWER SUPPLY CIRCUIT BOARD (See Figure 6-6)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C1	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
C2	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
C3	Capacitor, mica, 680pf ±5%, 300vdcw	1-900003-052	72136	DM15F681J	A	B
C4	Capacitor, mica, 680pf ±5%, 300vdcw	1-900003-052	72136	DM15F681J	A	B
C5	Capacitor, elect, 150uf, 25vdcw	1-900039-003	76433	974-143	A	B
C6	Capacitor, elect, 150uf, 25vdcw	1-900039-003	76433	974-143	A	B
C7	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
C8	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
C9	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
C10	Capacitor, elect, 1500uf, 25vdcw	1-900040-002	76433	977-206	A	B
CR1	Rectifier Bridge, 2 Amp	1-913006-001	02101	VS 248	A	B
CR2	Diode, Zener, 6.2V	1-913004-208	04713	Type MZ	A	B
CR3	Diode, Zener, 6.2V	1-913004-208	04713	Type MZ	A	B
F1	Fuse, 1/2 amp	1-924000-014	03614	Type MDL	A	B
Q1	Transistor	1-958022-001	79089	40450	A	B
Q2	Transistor	1-958023-002	79089	2N4037	A	B
Q3	Transistor	1-958000-001	04713	2N3904	A	B
Q4	Transistor	1-958000-002	04713	2N3906	A	B
Q5	Transistor	1-958000-001	04713	2N3904	A	B
Q6	Transistor	1-958000-002	04713	2N3906	A	B
R1	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R2	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R3	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R4	Resistor, comp, 470 ohms ±10%, 1/4W	1-945000-033	01121	Type CB	A	B
R5	Resistor, comp, 470 ohms ±10%, 1/4W	1-945000-033	01121	Type CB	A	B

POWER SUPPLY CIRCUIT BOARD (Continued)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R6	Resistor, comp, 560 ohms ±10%, 1/2W	1-945001-034	01121	Type EB	A	B
R7	Resistor, comp, 1K ±10%, 1/2W	1-945001-037	01121	Type EB	A	B
R8	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R9	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R10	Resistor, comp, 1K ±10%, 1/2W	1-945001-037	01121	Type EB	A	B
R11	Resistor, comp, 560 ohms ±10%, 1/2W	1-945001-034	01121	Type CB	A	B
R12	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R13	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R14	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R15	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	B
R16	Resistor, variable, 500 ohms ±30%, 1/4W	1-945010-003	71450	Type U 201	A	B
R17	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	B
R18	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	B
R19	Resistor, variable, 500 ohms ±30%, 1/4W	1-945010-003	71450	Type U201	A	B
R20	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	B
S1	Switch, Slide, DPDT	1-951003-002	82389	Type 46206LF	A	B

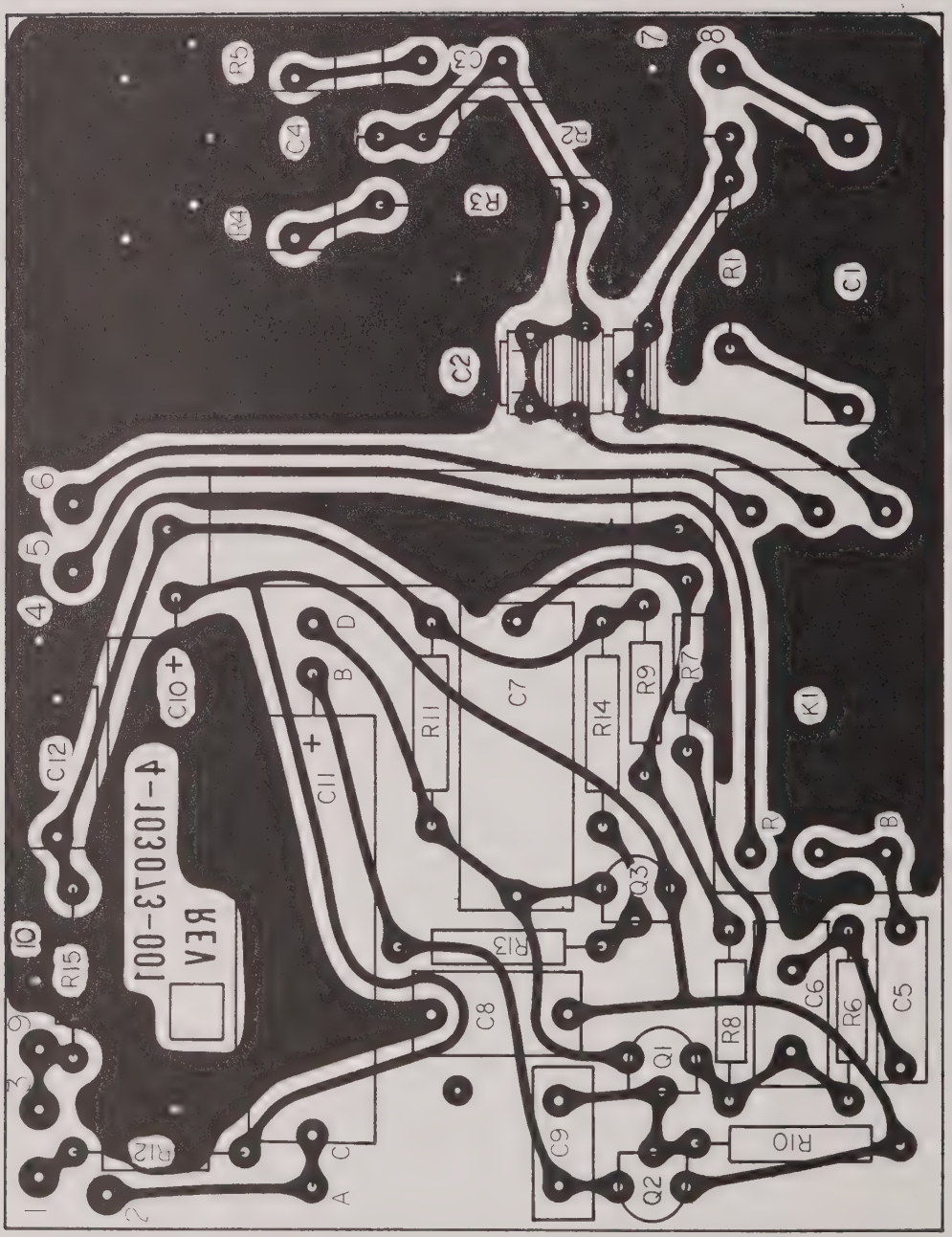


Figure 6-7a. Circuit Board Assembly, Signal Input, A6, PAV-4A

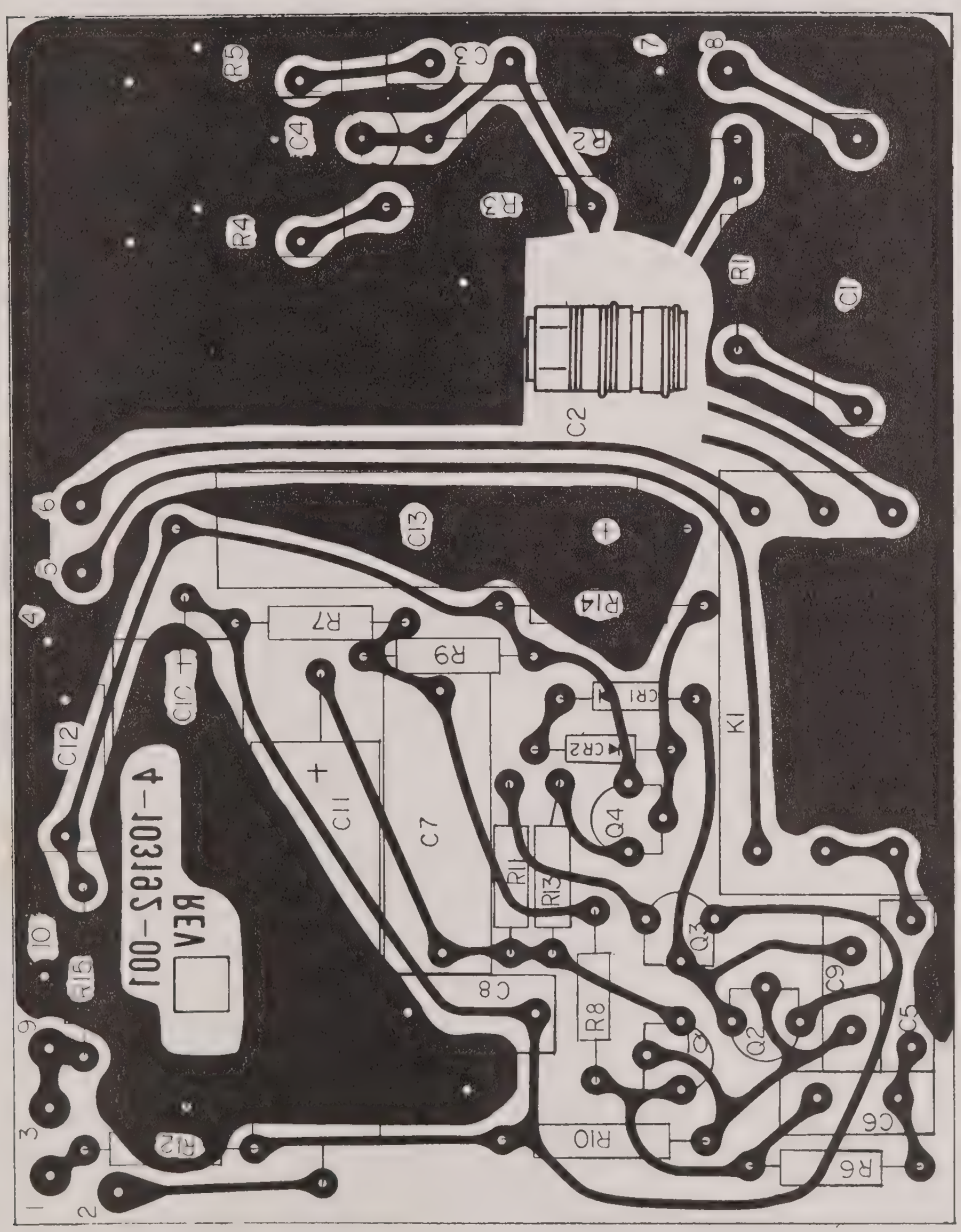


Figure 6-7b. Circuit Board Assembly, Signal Input, A6, PAV-4B

SIGNAL INPUT CIRCUIT BOARD A6 (See Figure 6-7)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C1	Capacitor, plastic, 0.1μf ±20%, 630V	1-900043-013	73445	Type C280CG	A	B
C2	Capacitor, variable, 1.5 - 10pf	1-900064-001	91293	7331	A	B
C3	Capacitor, mica, 1000pf ±5%, 100vdcw	1-900003-056	72136	DM15F102J	A	B
C4	Capacitor, mica, 820pf ±5%, 300vdcw	1-900003-054	72136	DM15F821J	A	B
C5	Capacitor, plastic, 0.01μf ±20%, 250vdcw	1-900001-001	73445	Type C280AE	–	B
	Capacitor, plastic, 0.47μf ±20%, 100vdc	1-900026-028	24152	17W-0.47μf	A	–
C6	Capacitor, mica, 47pf ±5%, 500vdcw	1-900003-021	72136	DM15F470J	–	B
	Capacitor, mica, 100pf, 500vdc	1-900003-030	72136	DM15F101J	A	–
C7	Capacitor, plastic, 0.47μf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C8	Capacitor, plastic, 0.1μf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C9	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
C10	Capacitor, elect, 200μf, 15vdcw	1-900039-002	76433	974-141	A	B
C11	Capacitor, elect, 200μf, 15vdcw	1-900039-002	76433	974-141	–	B
	Capacitor, elect, 50μf, 50vdc	1-900023-024	56689	TE1307	A	–
C12	Capacitor, plastic, 0.1μf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C13	Capacitor, elect, 200μf, 15vdcw	1-900039-002	76433	974-141	A	B
CR1	Diode	1-913007-001		1N4148	–	B
CR2	Diode	1-913007-001		1N4148	–	B
K1	Relay, reed	1-402791-001	88869		A	B
Q1	Transistor, FET	1-958047-001	04713	2N3822	A	B
Q2	Transistor, PNP	1-958000-002	04713	2N3906	A	B
Q3	Transistor, NPN	1-958000-001	04713	2N3904	A	B
Q4	Transistor, PNP	1-958000-002	04713	2N3906	–	B

SIGNAL INPUT CIRCUIT BOARD A6 (Continued)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R1	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R2	Resistor, film, 10 meg ±1%, 1/2W	1-945044-577	03327	Type M12	A	B
R3	Resistor, film, 30.9K ±1%, 1/4W	1-945016-336		Type RN60D	A	B
R4	Resistor, variable, ww, 2K	1-945039-008	02660	3800P 202	A	B
R5	Resistor, variable, ww, 2K	1-945039-008	02660	3800P 202	A	B
R6	Resistor, comp, 39K ±10%, 1/4W	1-945000-056	01121	Type CB	A	B
R7	Resistor, comp, 1 meg ±10%, 1/4W	1-945000-073	01121	Type CB	A	B
R8	Resistor, comp, 3.3 meg ±10%, 1/4W	1-945000-079	01121	Type CB	A	B
R9	Resistor, comp, 330K ±10%, 1/4W	1-945000-067	01121	Type CB	A	–
	Resistor, comp, 1.2 meg ±10%, 1/4W		01121	Type CB	–	B
R10	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R11	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	–
	Resistor, comp, 22 ohms ±10%, 1/4W	1-945000-017		Type RN60D	–	B
R12	Resistor, comp, 150 ohms ±10%, 1/4W	1-945000-027	01121	Type CB	A	B
R13	Resistor, film, 449 ohms ±1%, 1/4W	1-945016-164		Type RN60D	A	
	Resistor, comp, 22 ohms ±10%, 1/4W	1-945000-017		Type RN60D	–	B
R14	Resistor, film, 332 ohms ±1%, 1/4W	1-945016-147		Type RN60D	A	
	Resistor, film, 10K ±1%, 1/4W	1-945016-289		Type RN60D		B
R15	Resistor, comp, 150 ohms ±10%, 1/4W	1-945000-027	01121	Type CB	A	B

NOTES
1. CIRCUITRY SHOWN FOR REF ONLY.

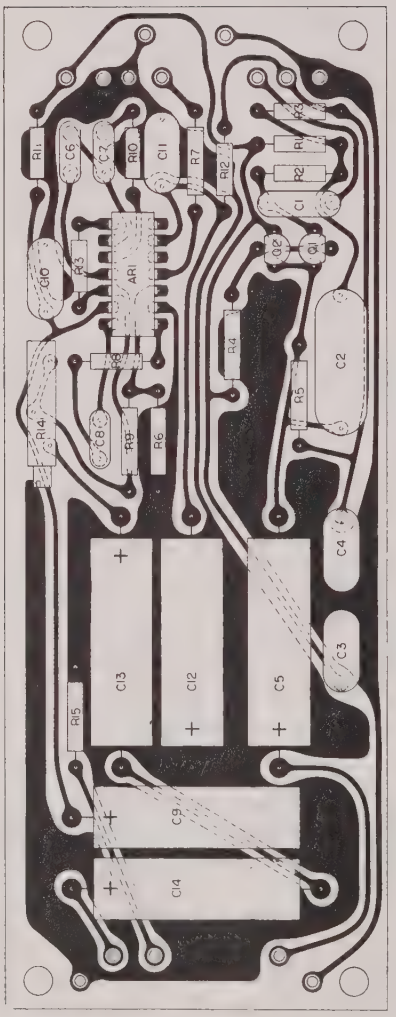
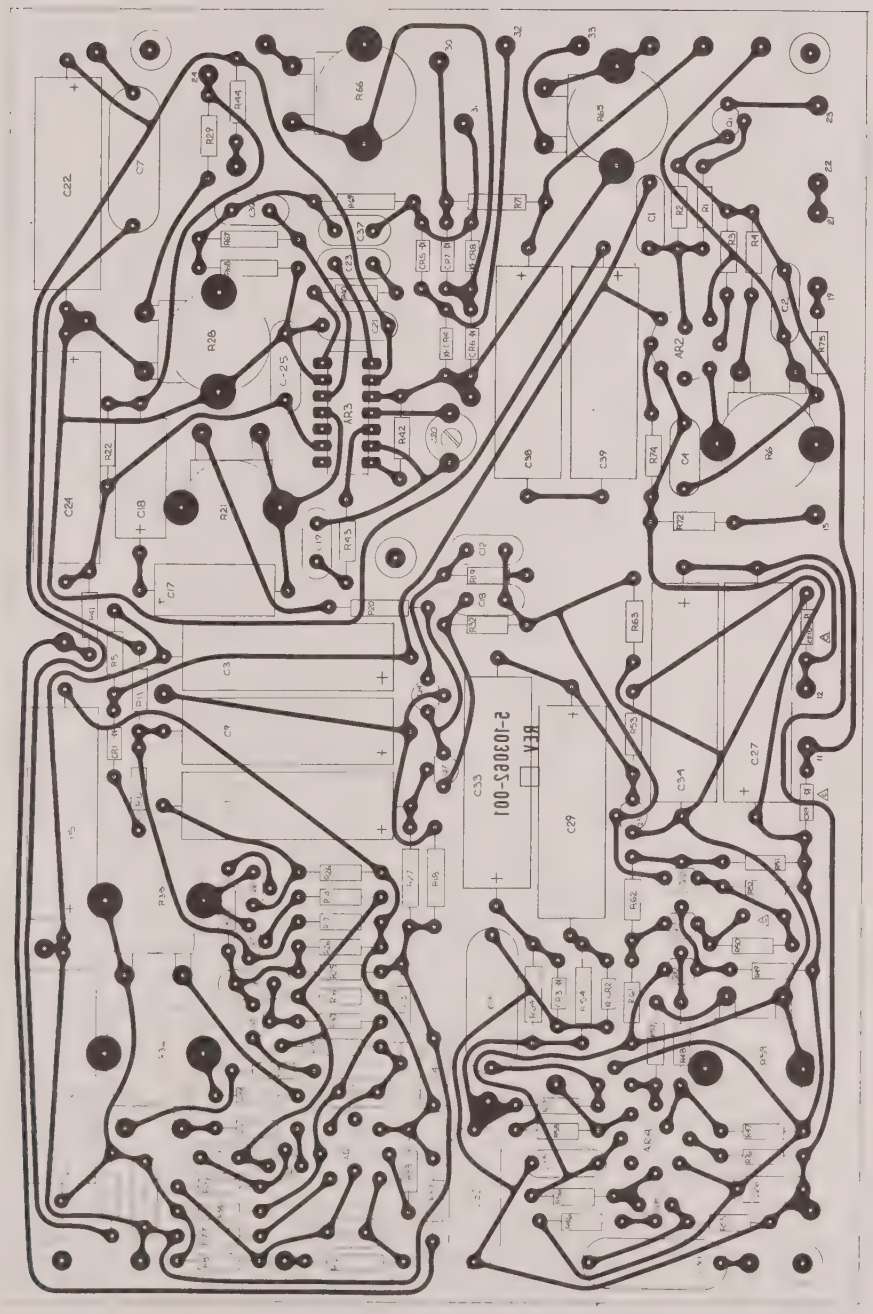


Figure 6-8. Circuit Board Assembly, X30 Signal, A7

X30 SIGNAL CIRCUIT BOARD A7 (See Figure 6-8)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
AR1	IC, Operational Amplifier	1-926006-001	79089	CA 3030	A	B
C1	Capacitor, plastic, 0.01uf ±20%, 250vdcw	1-900001-001	73445	Type C280AE	A	B
C2	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C3	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C4	Capacitor, plastic, 0.1uf ±10%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C5	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C6	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C7	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C8	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C9	Capacitor, elect, 200uf, 15vdcw	1-900039-008	76433	974-141	A	B
C10	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C11	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C12	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C13	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C14	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
Q1	Transistor, FET	1-958002-003	04713	MPF 105-5	A	B
Q2	Transistor	1-958000-002	04713	2N3906	A	B
R1	Resistor, comp, 2.2 meg ±10%, 1/4W	1-945000-077	01121	Type CB	A	B
R2	Resistor, comp, 3.3 meg ±10%, 1/4W	1-945000-079	01121	Type CB	A	B
R3	Resistor, comp, 220K ±10%, 1/4W	1-945000-065	01121	Type CB	A	B
R4	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R5	Resistor, film, 2K ±1%, 1/4W	1-945016-222		Type RN60D	A	B
R6	Resistor, film, 200 ohms ±1%, 1/4W	1-945016-126		Type RN60D	A	B
R7	Resistor, film, 200 ohms ±1%, 1/4W	1-945016-126		Type RN60D	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R8	Resistor, comp, 680 ohms ±10%, 1/4W	1-945000-035	01121	Type CB	A	B
R9	Resistor, film, 6.65K ±1%, 1/4W	1-945016-272		Type RN60D	A	B
R10	Resistor, comp, 680 ohms ±10%, 1/4W	1-945000-035	01121	Type CB	A	B
R11	Resistor, comp, 390 ohms ±10%, 1/4W	1-945000-032	01121	Type CB	A	B
R12	Resistor, comp, 390 ohms ±10%, 1/4W	1-945000-032	01121	Type CB	A	B
R13	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R14	Resistor, variable, ww, 200 ohms	1-945039-005	02660	3800 P201	A	B
R15	Resistor, film, 200 ohms ±1%, 1/4W	1-945016-126		Type RN60D	A	B


R66
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R26
C24
C18
R21
C17
R22
C3
C9
C25
R43
R42
AR3
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DETECTOR CIRCUIT BOARD A8 (See Figure 6-9)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
AR1	IC, Diff. cascade amp.	1-926005-001	79089	CA 3028	A	B
AR2	IC, Diff. cascade amp.	1-926005-001	79089	CA 3028	A	B
AR3	IC, Operational amplifier	1-926006-001	79089	CA 3030	A	B
AR4	IC, Diff. cascade amp.	1-926005-001	79089	CA 3028	A	B
C1	Capacitor, plastic, 0.01uf ±20%, 250vdcw	1-900001-001	73445	Type C280AE	A	B
C2	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C3	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C4	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C5	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C6	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C7	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C8	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C9	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C10	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C11	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C12	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
C13	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
C14	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C15	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C16	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
C17	Capacitor, elect, 25uf, 25vdcw	1-900039-001	76433	974-118	A	B
C18	Capacitor, elect, 25uf, 25vdcw	1-900039-001	76433	974-141	A	B
C19	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C20	Capacitor, variable, 5 - 18pf	1-900031-002	15450	538-011-5.5-18PFA	A	B
C20 PAV-4C only	Capacitor, 200pf (exact value determined in test)			DM 15		

DETECTOR CIRCUIT BOARD A8 (Continued)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C21	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C22	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C23	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C24	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C25	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C26	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C27	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C29	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C30	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C31	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C32	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	A	B
C33	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C34	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C35	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C36	Capacitor, mica, 680pf ±5%, 300vdcw	1-900003-052	72136	DM15F681J	A	B
C37	Capacitor, mica, 68pf ±5%, 500vdcw	1-900003-026	72136	DM15E680J	A	B
C38	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C39	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C40	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	A	B
CR1	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR2	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR3	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR4	Diode, silicon	1-913007-001	03508	1N4148	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
CR5	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR6	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR7	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR8	Diode, silicon	1-913007-001	03508	1N4148	A	B
CR9	Diode, Zener, 5.1V, 1W	1-913004-006	04713	Type MZ	A	B
CR10	Diode, Zener, 5.1V, 1W	1-913004-006	04713	Type MZ	A	B
Q1	Transistor	1-958000-002	04713	2N3906	A	B
Q2	Transistor	1-958000-002	04713	2N3906	A	B
Q3	Transistor	1-958000-001	04713	2N3904	A	B
Q4	Transistor, FET	1-958002-003	04713	MPF 105 - 5	A	B
Q5	Transistor	1-958000-002	04713	2N3906	A	B
Q6	Transistor	1-958000-001	04713	2N3904	A	B
Q7	Transistor, FET	1-958021-003	04713	MPF 153 - 5	A	B
Q8	Transistor, FET	1-958002-003	04713	MPF 105 - 5	A	B
Q9	Transistor, FET	1-958002-003	04713	MPF 105 - 5	A	B
Q10	Transistor	1-958000-002	04713	2N3906	A	B
Q11	Transistor	1-958000-002	04713	2N3906	A	B
Q12	Transistor	1-958000-002	04713	2N3906	A	B
Q13	Transistor	1-958000-002	04713	2N3906	A	B
R1	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R2	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-009	01121	Type CB	A	B
R3	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R4	Resistor, comp, 6.8K ±10%, 1/4W	1-945000-047	01121	Type CB	A	B
R5	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB	A	B
R6	Resistor, variable, 5K ±30%, 1/4W	1-945010-006	71450	Type U201	A	B
R7	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R8	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R9	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R10 (S/N to 400 only)	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R11	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B
R12	Resistor, film, 2K ±1%, 1/4W	1-945016-222		Type RN60D	A	B
R13	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R14	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R15	Resistor, film, 20K ±1%, 1/4W	1-945016-318		Type RN60D	A	B
R16	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R17	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R18	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R19	Resistor, comp, 2.2 meg ±10%, 1/4W	1-945000-077	01121	Type CB	A	B
R20	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R21	Resistor, variable, 1K ±30%, 1/4W	1-945010-004	71450	Type U201	A	B
R22	Resistor, comp, 2.2 meg ±10%, 1/4W	1-945000-077	01121	Type CB	A	B
R23	Resistor, film, 2K ±1%, 1/4W	1-945016-222		Type RN60D	A	B
R24	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-053	01121	Type CB	A	B
R25	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R26	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R27	Resistor, comp, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R28	Resistor, variable, 1K ±20%, 1/4W	1-945010-004	71450	Type U201	A	B
R29	Resistor, comp, 470 ohms ±10%, 1/4W	1-945000-033	01121	Type CB	A	B
R30	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R31	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R32	Resistor, comp, 2.2 meg ±10%, 1/4W	1-945000-077	01121	Type CB	A	B
R33	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R34	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R35	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B
R36	Resistor, variable, 100 ohms ±30%, 1/4W	1-945010-001	71450	Type U201	A	B
R37	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R38	Resistor, variable, 500 ohms ±30%, 1/4W	1-945010-003	01121	Type CB	A	B
R39	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R40	Resistor, comp, 680 ohms ±10%, 1/4W	1-945000-035	01121	Type CB	A	B
R41	Resistor, comp, 150 ohms ±10%, 1/4W	1-945000-027	01121	Type CB	A	B
R42	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-009	01121	Type CB	A	B
R43	Resistor, comp, 680 ohms ±10%, 1/4W	1-945000-035	01121	Type CB	A	B
R44	Resistor, comp, 150 ohms ±10%, 1/4W	1-945000-027	01121	Type CB	A	B
R45	Not Used					
R46	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R47	Resistor, comp, 3.9K ±10%, 1/4W	1-945000-044	01121	Type CB	A	B
R48	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R49	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-009	01121	Type CB	A	B
R50	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R51	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB	A	B
R52	Resistor, comp, 100 ohms ±10%, 1/4W	1-945000-025	01121	Type CB	A	B
R53	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R54	Resistor, film, 100K ±1%, 1/4W	1-945016-385		Type RN60D	A	B
R55	Resistor, comp, 1 meg ±10%, 1/4W	1-945000-073	01121	Type CB	A	B
R56	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R57	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R58	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R59	Resistor, variable, 10K ±30%, 1/4W	1-945010-007	71450	Type U201	A	B
R60	Not Used					
R61	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	A	B
R62	Resistor, comp, 22K ±10%, 1/4W	1-945000-053	01121	Type CB	A	B
R63	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R64	Resistor, film, 100K ±1%, 1/4W	1-945016-385		Type RN60D	A	B
R65	Resistor, variable, 1K ±30%, 1/4W	1-945010-004	71450	Type U201	A	B
R66	Resistor, variable, 1K ±30%, 1/4W	1-945010-004	71450	Type U201	A	B

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
R67	Resistor, film, 2.43K ±1%, 1/4W	1-945016-230		Type RN60D	A	B
R68	Resistor, film, 200 ohms ±1%	1-945016-126		Type RN60D	A	B
R69	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R70	Resistor (Not Used)				A	B
R71	Resistor, film 332 ohms ±1%, 1/4W	1-945016-147		Type RN60D	A	B
R72	Resistor, comp, 330 ohms ±10%, 1/4W	1-945000-031	01121	Type CB	A	B
R73	Resistor, comp, 1 meg ±10%, 1/4W	1-945000-073	01121	Type CB	A	B
R74	Resistor, comp. 1.5K ±10%, 1/4W	1-945000-039	01121	Type CB	A	B
R75	Resistor, comp, 330 ohms ±10%, 1/4W	1-945000-031	01121	Type CB	A	B
R76	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R77	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B

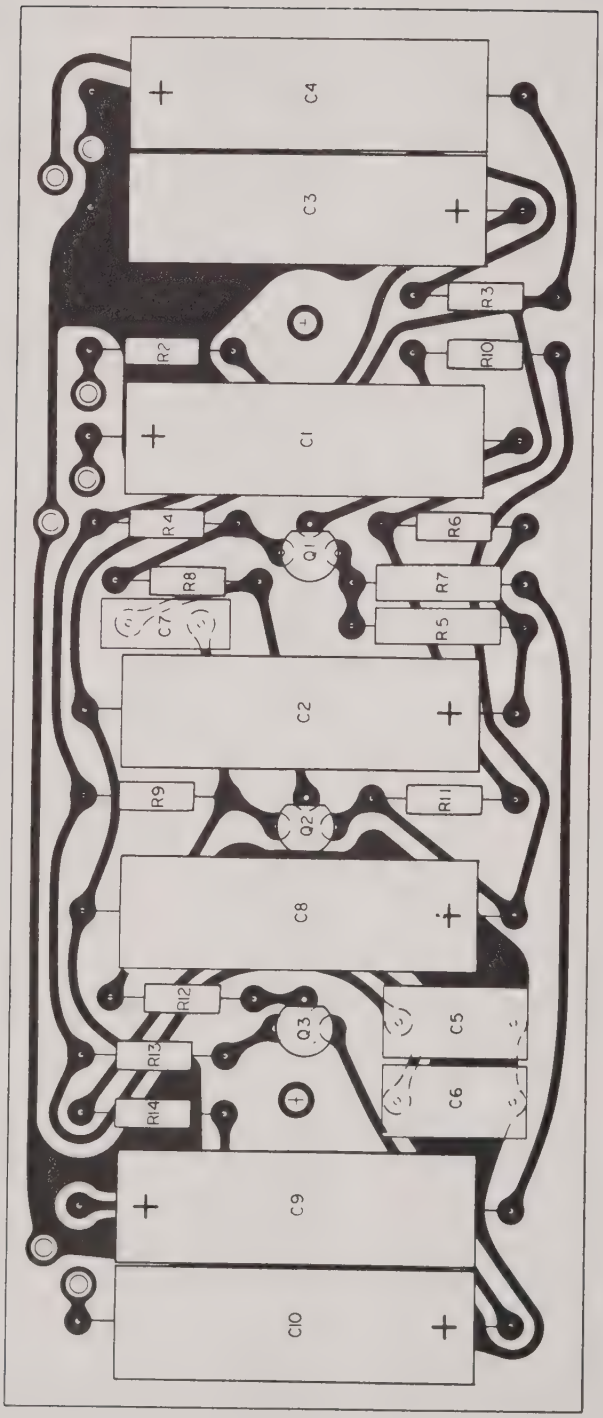


Figure 6-10. Circuit Board Assembly, Reference X5, A9

REFERENCE X5 CIRCUIT BOARD A9 (See Figure 6-10)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV4B
C1	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C2	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C3	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C4	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C5	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C6	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	A	B
C7	Capacitor, mica, 10pf ±5%, 500vdcw	1-900003-008	72136	DM15C100J	A	B
C8	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C9	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
C10	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	A	B
Q1	Transistor	1-958000-001	04713	2N3904	A	B
Q2	Transistor	1-958000-001	04713	2N3904	A	B
Q3	Transistor	1-958000-001	04713	2N3904	A	B
R1	Resistor (Not Used)					
R2	Resistor, comp, 220 ohms ±10%, 1/4W	1-945000-029	01121	Type CB	A	B
R3	Resistor, comp, 220 ohms ±10%, 1/4W	1-945000-029	01121	Type CB	A	B
R4	Resistor, comp, 8.2K ±10%, 1/4W	1-945000-048	01121	Type CB	A	B
R5	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	A	B
R6	Resistor, comp, 1.5K ±10%, 1/4W	1-945000-039	01121	Type CB	A	B
R7	Resistor, film, 4.99K ±1%, 1/4W	1-945016-260		Type RN60D	A	B
R8	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R9	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB	A	B
R10	Resistor, comp, 27K ±10%, 1/4W	1-945000-054	01121	Type CB	A	B
R11	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B
R12	Resistor, comp, 10 ohms ±10%, 1/4W	1-945000-013	01121	Type CB	A	B
R13	Resistor, comp, 47 ohms ±10%, 1/4W	1-945000-021	01121	Type CB	A	B
R14	Resistor, comp, 2.2K ±10%, 1/4W	1-945000-041	01121	Type CB	A	B

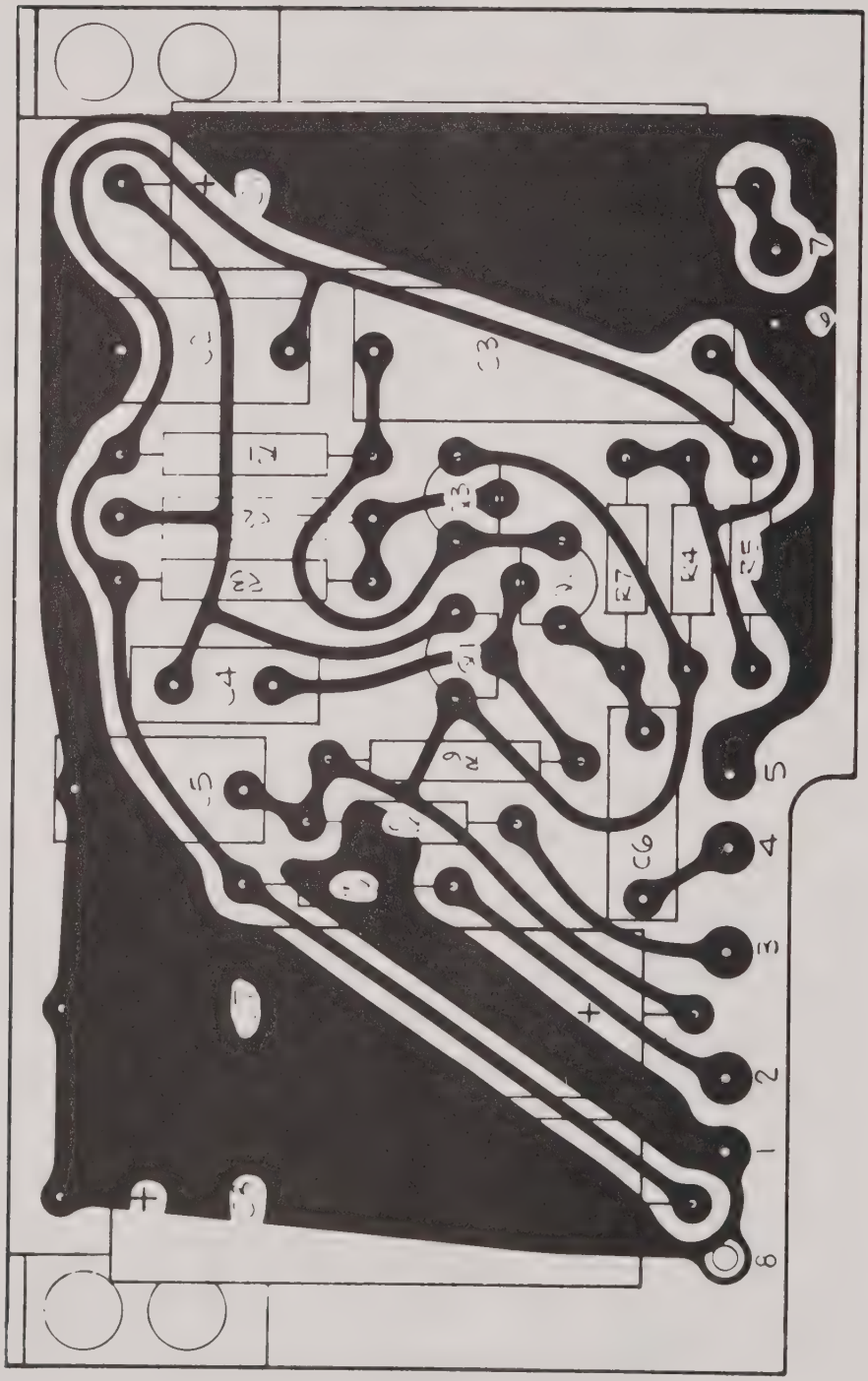


Figure 6-11. Circuit Board Assembly, Isolation Input, A10, A12

ISOLATION INPUT CIRCUIT BOARDS A10, A12 (See Figure 6-11)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C1	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C2	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	–	B
C3	Capacitor, plastic, 0.47uf ±20%, 250vdcw	1-900001-021	73445	Type C280AE	–	B
C4	Capacitor, mica, 22pf ±5%, 500vdcw	1-900003-013	72136	DM15E220J	–	B
C5	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	–	B
C6	Capacitor, plastic, 0.01uf ±20%, 250vdcw	1-900001-001	73445	Type C280AE	–	B
C7	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C8	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C9 (on A10, PAV-4C only)	Capacitor, 390pf, selected value determined in test		04062	DM 15		
Q1	Transistor, PNP	1-958000-002	04713	2N3906	–	B
Q2	Transistor, FET	1-958031-003		E 102	–	B
Q3	Transistor, NPN	1-958000-001	04713	2N3904	–	B
A10R1	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	–	B
A12R1	Resistor, film, 4.99K ±10%, 1/4W	1-945016-xxx		Type RN60D	–	B
A10R2	Resistor, film, 499 ohms ±1%, 1/4W	1-945016-164		Type RN60D	–	B
A12R2	Not Used				–	B
A10R3	Resistor, film, 332 ohms ±1%, 1/4W	1-945016-147		Type RN60D	–	B
A12R3	Resistor, comp, 680 ohms ±10%, 1/2W		01121	Type EB	–	B
R4	Resistor, comp, 1 meg ±10%, 1/4W	1-945000-073	01121	Type CB	–	B
A10R5	Resistor, comp, 220K ±10%, 1/4W	1-945000-065	01121	Type CB	–	B
A12R5	Resistor, comp, 1.5M ±10%, 1/4W		01121	Type CB	–	B
R6	Resistor, film, 1K ±1%, 1/4W	1-945016-193		Type RN60D	–	B
R7	Resistor, comp, 3.3 meg ±10%, 1/4W	1-945000-0791	01121	Type CB	–	B
R8	Resistor, comp, 220 ohms ±10%, 1/4W	1-945000-079	01121	Type CB	–	B
R9	Resistor, comp, 220 ohms ±10%, 1/4W	1-945000-029	01121	Type CB	–	B

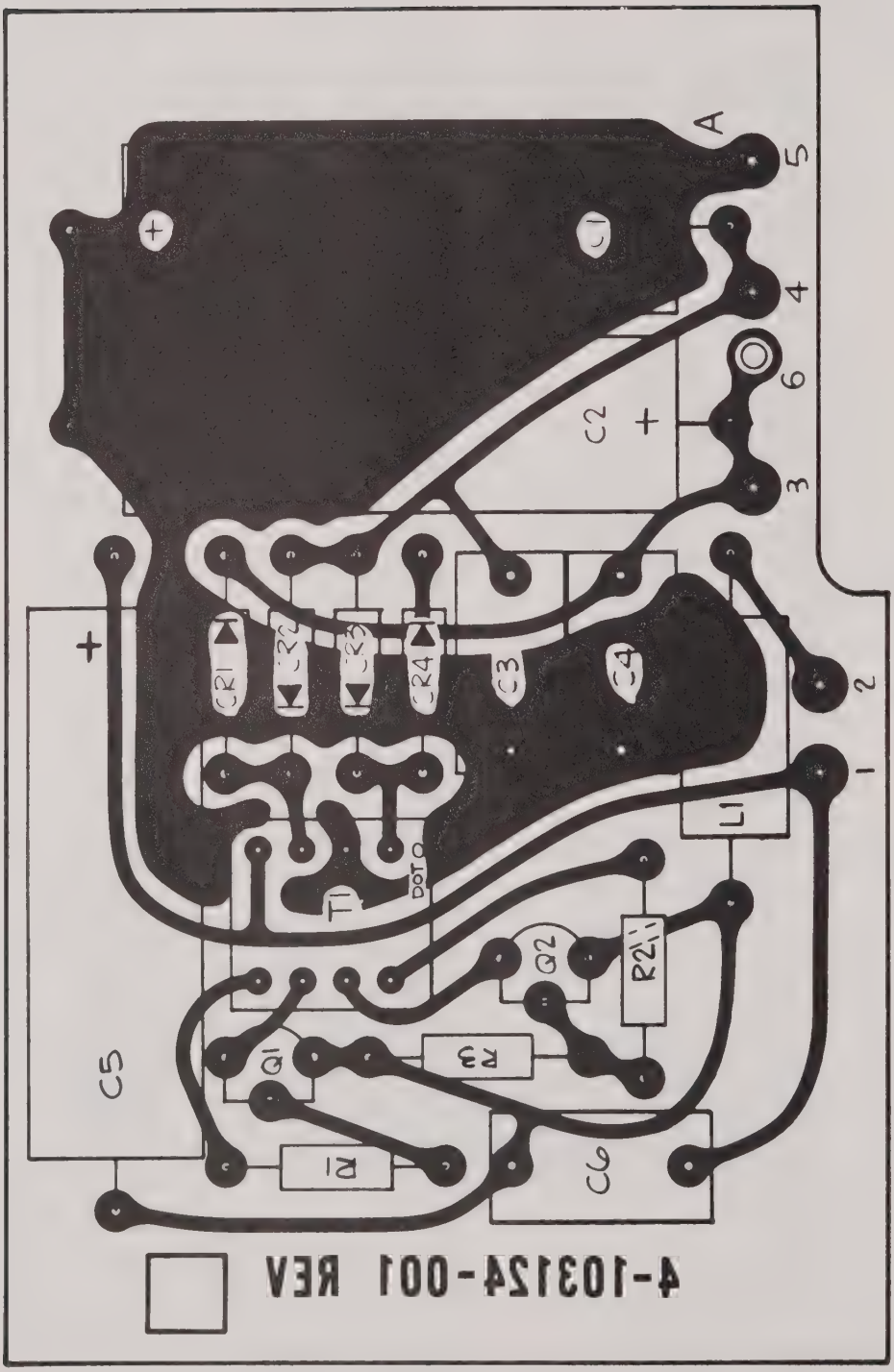


Figure 6-12. Circuit Board Assembly, Isolation Inverter, A11, A13

ISOLATION INVERTER CIRCUIT BOARD A11, A13 (See Figure 6-12)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.	PAV-4A	PAV-4B
C1	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C2	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C3	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	–	B
C4	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	–	B
C5	Capacitor, elect, 200uf, 15vdcw	1-900039-002	76433	974-141	–	B
C6	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE	–	B
CR1	Diode	1-913000-001	01295	1N914	–	B
CR2	Diode	1-913000-001	01295	1N914	–	B
CR3	Diode	1-913000-001	01295	1N914	–	B
CR4	Diode	1-913000-001	01295	1N914	–	B
L1	Choke, 1mh	1-906007-003	04213	670-3	–	B
Q1	Transistor, PNP	1-958000-002	04713	2N3906	–	B
Q2	Transistor, PNP	1-958000-002	04713	2N3906	–	B
R1	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	–	B
R2	Resistor, comp, 1K ±10%, 1/4W	1-945000-037	01121	Type CB	–	B
R3	Resistor, comp, 22K ±10%, 1/4W	1-945000-053	01121	Type CB	–	B
T1	Transformer	1-402894-001	88869		–	B

SECTION VII

SINGLE FREQUENCY MODULE

7-1. DESCRIPTION

7-2. Refer to paragraphs 1-9 and 4-11 for a description of the module. Refer to paragraph 5-16 for adjustments. Refer to figure 7-1 for schematic. Refer to figure 7-2 for circuit board layout.

7-3. PARTS LIST

7-4. Refer to paragraphs 6-1 through 6-4 for parts list application.

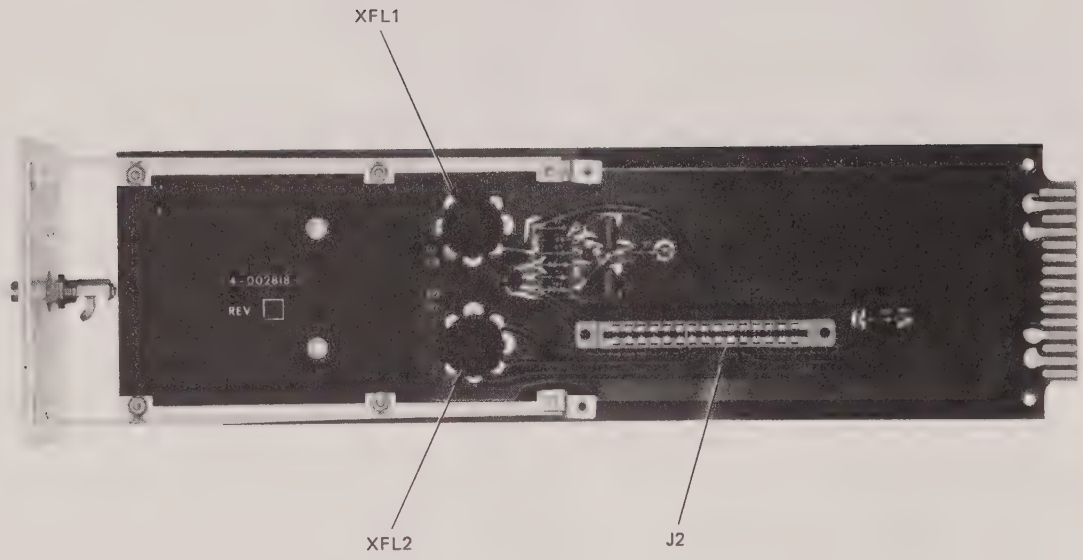


Figure 7-1. Single Frequency Module, Top View

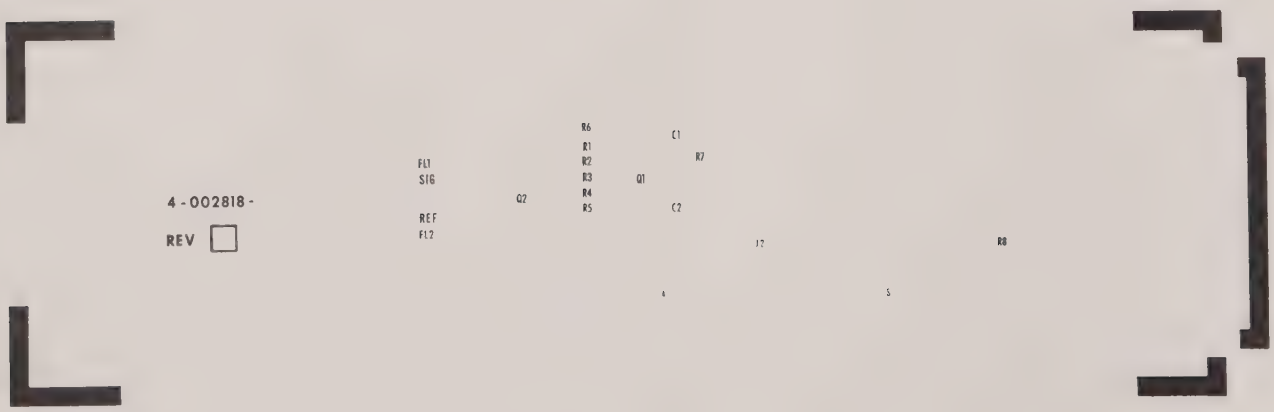


Figure 7-2. Location of Parts, SF Module, Mother Board

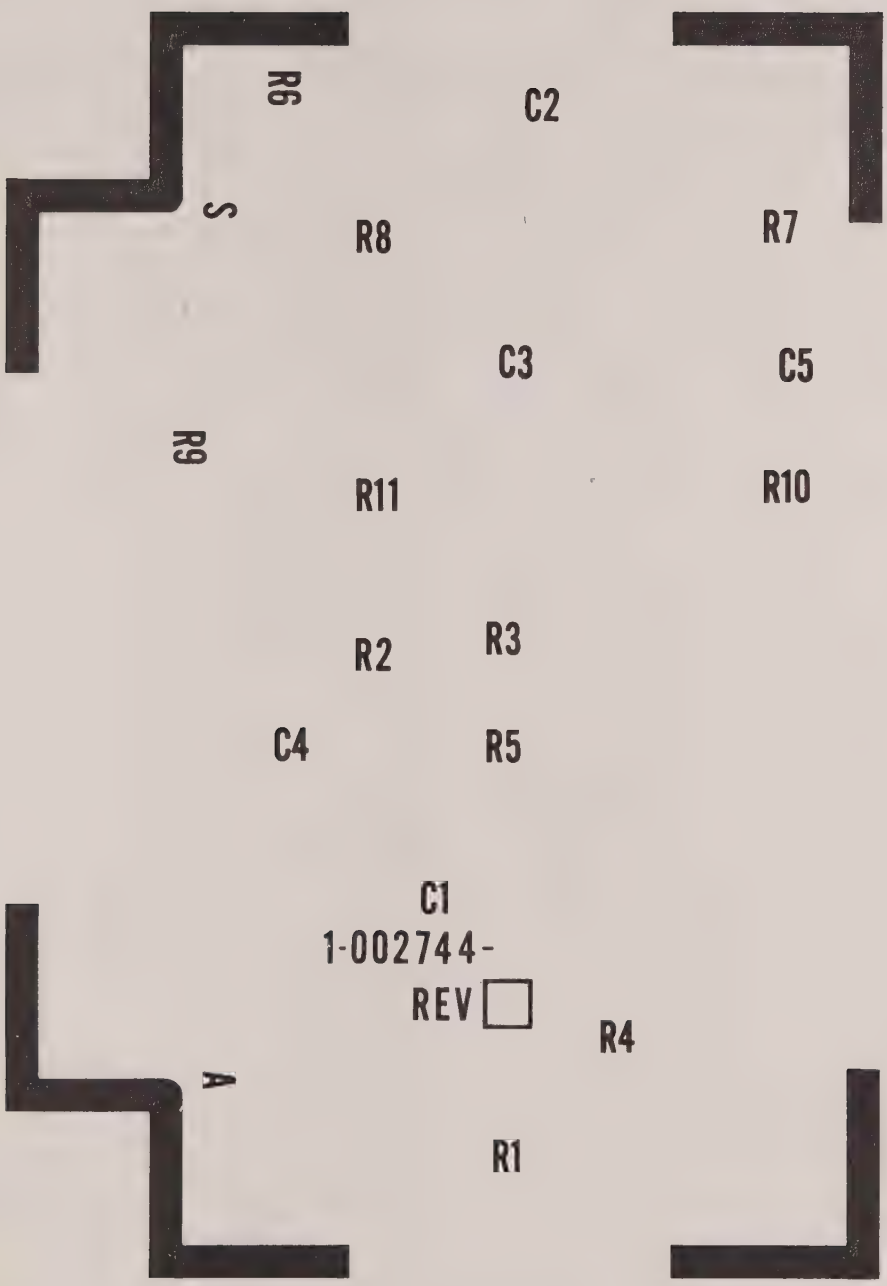


Figure 7-3. Location of Parts, SF Module, Network Board

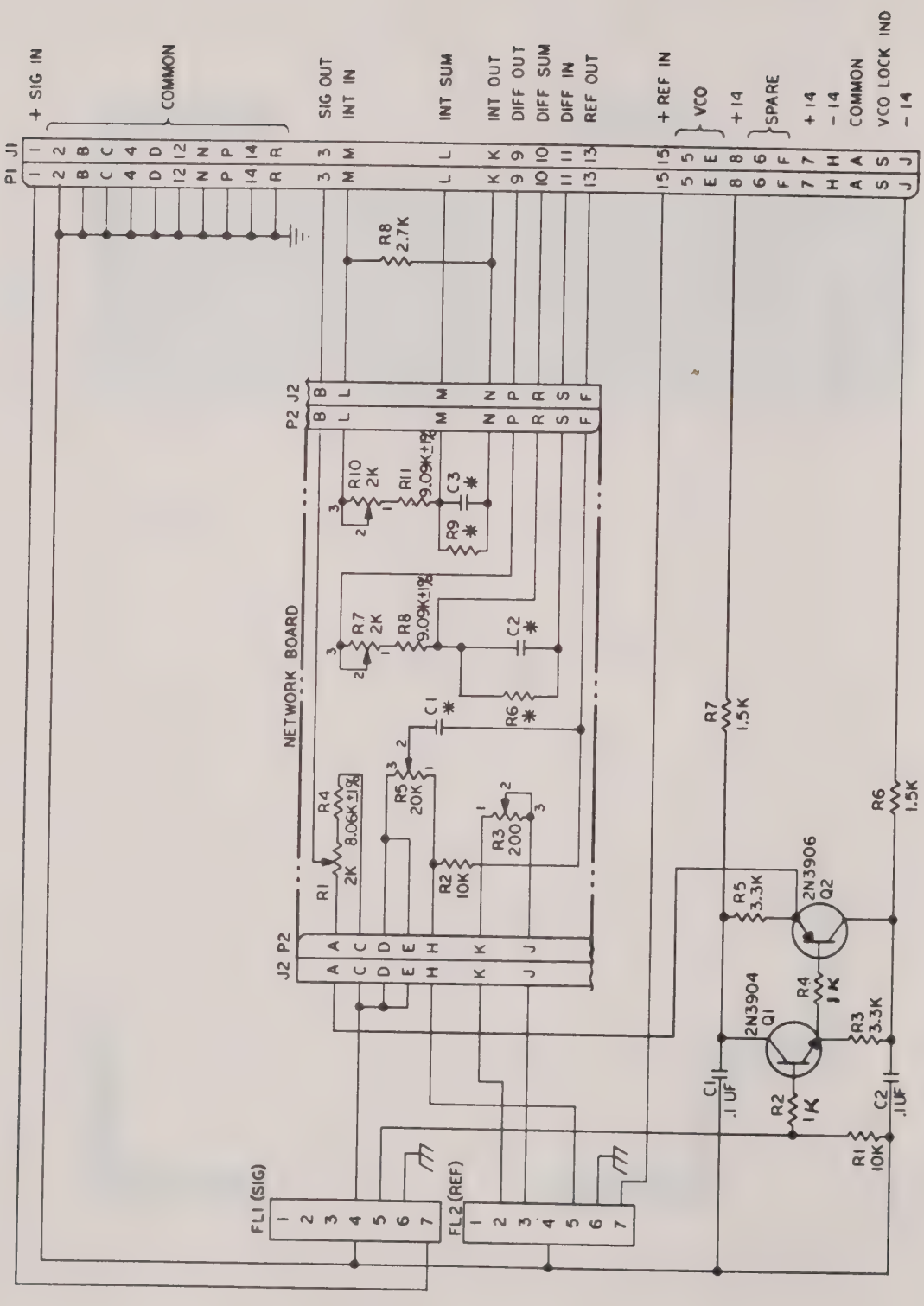


Figure 7-4. Schematic Diagram, SF Module, Mother Board and Network Board

PARTS LIST
SINGLE FREQUENCY PLUG-IN, MOTHER BOARD (See figures 7-1 and 7-2)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.
C1	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE
C2	Capacitor, plastic, 0.1uf ±20%, 250vdcw	1-900001-013	73445	Type C280AE
FL1	Filter, determined by frequency	1-402794-xxx	88869	
FL2	Filter, determined by frequency	1-402794-xxx	88869	
J2	Connector	1-910070-103	05574	2VK155 2-2
Q1	Transistor	1-958000-001	04713	2N3904
Q2	Transistor	1-958000-002	04713	2N3906
R1	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB
R2	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R3	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R4	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R5	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R6	Resistor, comp, 1.5K ±10%, 1/4W	1-945000-039	01121	Type CB
R7	Resistor, comp, 1.5K ±10%, 1/4W	1-945000-039	01121	Type CB
R8	Resistor, comp, 2.7K ±10%, 1/4W	1-945000-042	01121	Type CB

NOTE: Values of Network Board components are not given since they change with each plug-in frequency.

SECTION VIII

MULTIPLE FREQUENCY MODULE

8-1. DESCRIPTION

8-2. Refer to paragraphs 1-10 and 4-11 for a description of the module. Refer to paragraph 5-17 for adjustments. Refer to figure 8-1 for schematic. Refer to figure 8-2 for circuit board layout.

8-3. PARTS LIST

8-4. Refer to paragraphs 6-1 through 6-4 for parts list application.

The schematic and location of parts diagram for each MF Network Board are identical to those for the SF Network Board (see figures 7-3 and 7-4).

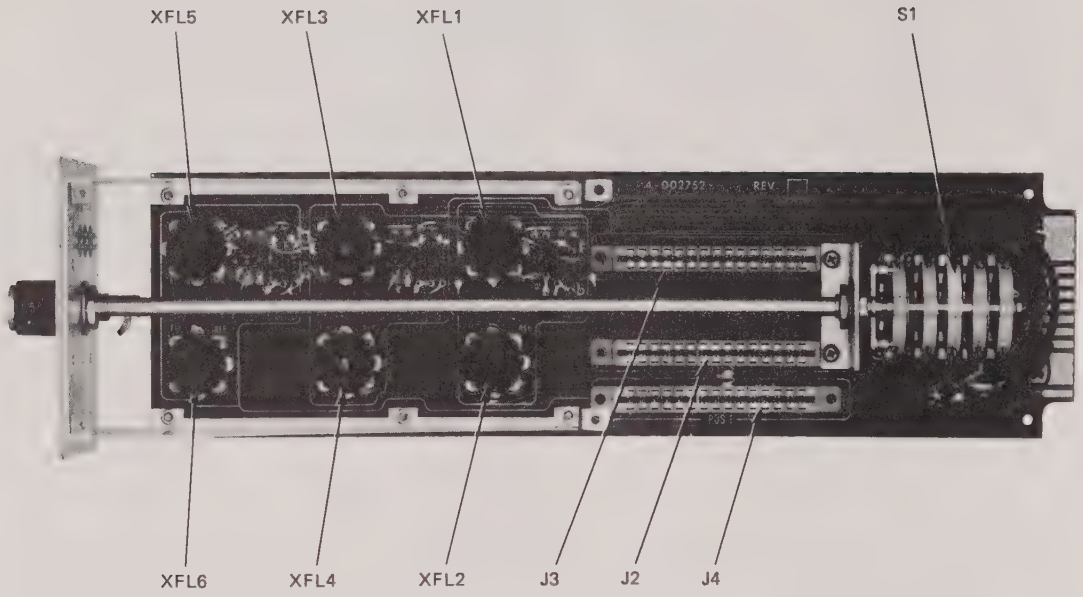


Figure 8-1. Location of Parts, MF Module

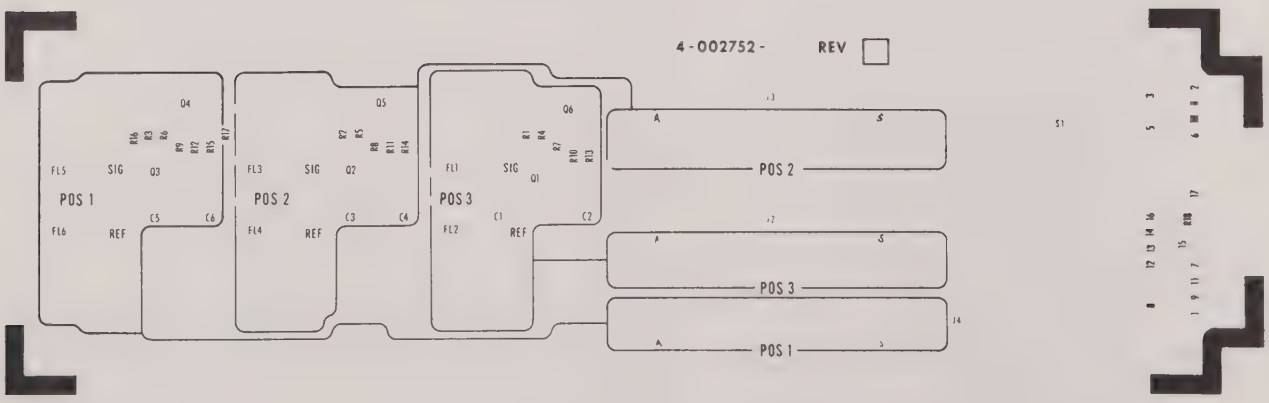
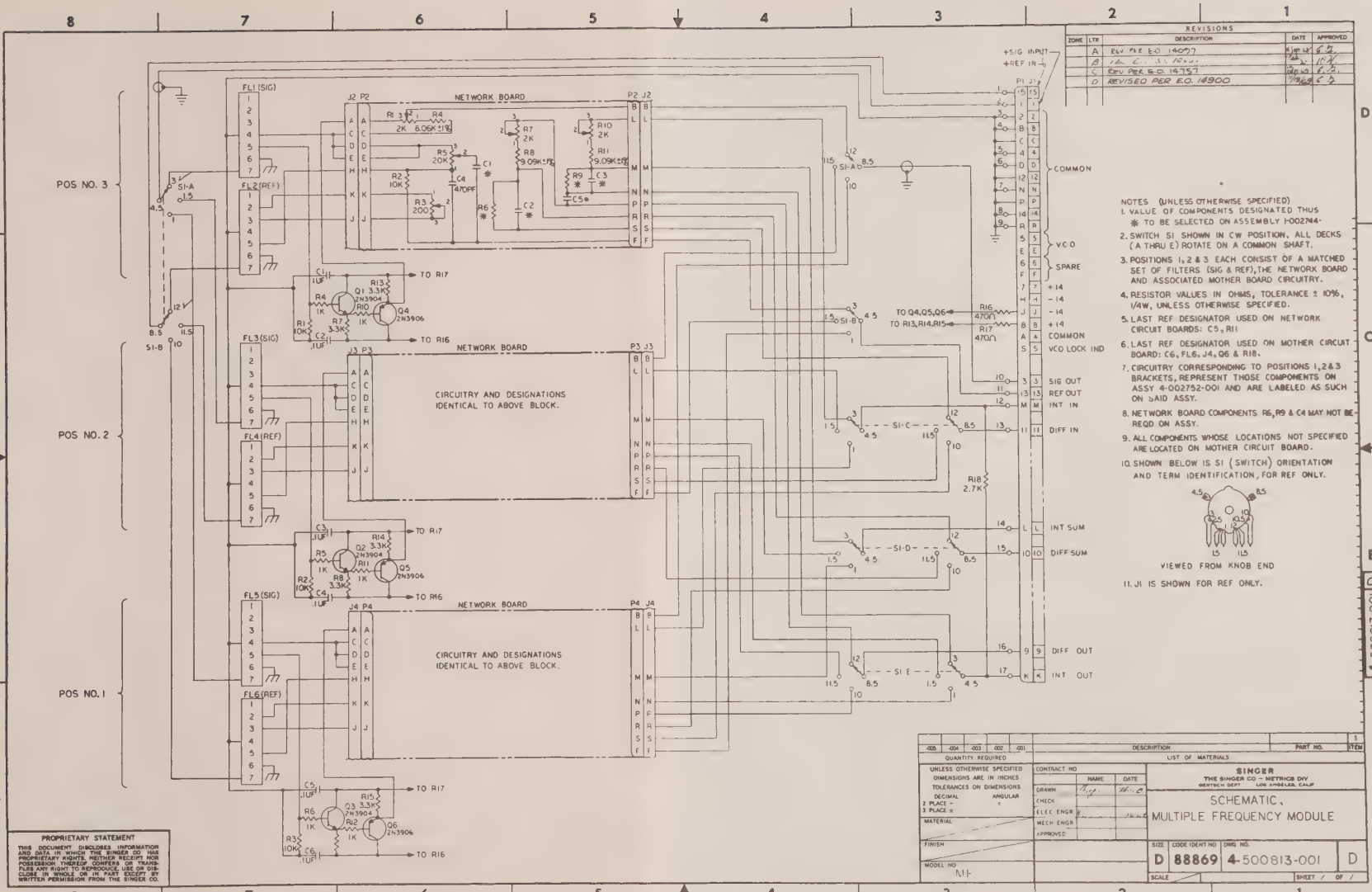


Figure 8-2. Location of Parts, MF Module, Mother Board


REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPROVED
A REV PER E.O. 14027
B REV PER E.O. 14050
C REV PER E.O. 14757
D REVISED PER E.O. 14900
POS NO. 3
POS NO. 2
POS NO. 1
FL1 (SIG)
FL2 (REF)
FL3 (SIG)
FL4 (REF)
FL5 (SIG)
FL6 (REF)
NETWORK BOARD
CIRCUITRY AND DESIGNATIONS IDENTICAL TO ABOVE BLOCK.
+SIG INPUT
+REF IN
COMMON
VCO
SPARE
+14
-14
VCO LOCK IND
SIG OUT
REF OUT
INT IN
DIFF IN
INT SUM
DIFF SUM
DIFF OUT
INT OUT
NOTES (UNLESS OTHERWISE SPECIFIED)
1. VALUE OF COMPONENTS DESIGNATED THUS * TO BE SELECTED ON ASSEMBLY 1-002744.
2. SWITCH S1 SHOWN IN CW POSITION. ALL DECKS (A THRU E) ROTATE ON A COMMON SHAFT.
3. POSITIONS 1, 2 & 3 EACH CONSIST OF A MATCHED SET OF FILTERS (SIG & REF), THE NETWORK BOARD AND ASSOCIATED MOTHER BOARD CIRCUITRY.
4. RESISTOR VALUES IN OHMS, TOLERANCE ± 10%, 1/4W, UNLESS OTHERWISE SPECIFIED.
5. LAST REF DESIGNATOR USED ON NETWORK CIRCUIT BOARDS: C5, R11
6. LAST REF DESIGNATOR USED ON MOTHER CIRCUIT BOARD: C6, FL6, J4, Q6 & R18.
7. CIRCUITRY CORRESPONDING TO POSITIONS 1, 2 & 3 BRACKETS, REPRESENT THOSE COMPONENTS ON ASSY 4-002752-001 AND ARE LABELED AS SUCH ON SAID ASSY.
8. NETWORK BOARD COMPONENTS R6, R9 & C4 MAY NOT BE REQD ON ASSY.
9. ALL COMPONENTS WHOSE LOCATIONS NOT SPECIFIED ARE LOCATED ON MOTHER CIRCUIT BOARD.
10. SHOWN BELOW IS S1 (SWITCH) ORIENTATION AND TERM IDENTIFICATION, FOR REF ONLY.
VIEWED FROM KNOB END
11. J1 IS SHOWN FOR REF ONLY.
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LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DIMENSIONS DECIMAL 2 PLACE ± 3 PLACE ± ANGULAR ±
MATERIAL
FINISH
MODEL NO N1F
CONTRACT NO
DRAWN
CHECK
ELEC ENGR
MECH ENGR
APPROVED
SINGER
THE SINGER CO — METRICS DIV
GENTSCH DEPT LOS ANGELES, CALIF
SCHEMATIC, MULTIPLE FREQUENCY MODULE
SIZE D | CODE IDENT NO 88869 | DWG NO 4-500813-001 | D
SCALE
SHEET / OF /
4-500813-001 D

Figure 8-3. Schematic Diagram, MF Module

PARTS LIST
MULTIPLE FREQUENCY PLUG-IN (See figure 8-2)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.
A1	Network Board, frequency position No. 3; specify frequency	1-002744-xxx	88869	
A2	Network Board, frequency position No. 2; specify frequency	1-002744-xxx	88869	
A3	Network Board, frequency position No. 1; specify frequency	1-002744-xxx	88869	
C1	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
C2	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
C3	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
C4	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
C5	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
C6	Capacitor, plastic, 0.1uf ±20%, 250vdc	1-900001-013	73445	Type C280AE
FL1	Filter, signal channel, position No. 3; specify frequency	1-402794-xxx	88869	
FL2	Filter, reference channel, position No. 3; specify frequency	1-402794-xxx	88869	
FL3	Filter, signal channel, position No. 2; specify frequency	1-402794-xxx	88869	
FL4	Filter, reference channel, position No. 2; specify frequency	1-402794-xxx	88869	
FL5	Filter, signal channel position No. 1; specify frequency	1-402794-xxx	88869	
FL6	Filter, reference channel, position No. 1; specify frequency	1-402794-xxx	88869	
J2	Connector	1-910070-003	05574	2VK15S 2-3
J3	Connector	1-910070-003	05574	2VK15S 2-3
J4	Connector	1-910070-103	05574	2VK15S 2-2
Q1	Transistor	1-958000-001	04713	2N3904
Q2	Transistor	1-958000-001	04713	2N3904
Q3	Transistor	1-958000-001	04713	2N3904
Q4	Transistor	1-958000-001	04713	2N3906
Q5	Transistor	1-958000-002	04713	2N3906
Q6	Transistor	1-958000-002	04713	2N3906

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG CODE	MFG PART NO.
R1	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB
R2	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB
R3	Resistor, comp, 10K ±10%, 1/4W	1-945000-049	01121	Type CB
R4	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R5	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R6	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R7	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R8	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R9	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R10	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R11	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R12	Resistor, comp, 1K ohms ±10%, 1/4W	1-945000-037	01121	Type CB
R13	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R14	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R15	Resistor, comp, 3.3K ±10%, 1/4W	1-945000-043	01121	Type CB
R16	Resistor, comp, 470 ohms ±10%, 1/4W	1-945000-033	01121	Type CB
R17	Resistor, comp, 470 ohms ±10%, 1/4W	1-945000-033	01121	Type CB
R18	Resistor, comp, 2.7K ±10%, 1/4W	1-945000-042	01121	Type CB
S1	Switch, rotary	4-402862-001	88869	
XFL1 thru XFL2	Socket	1-950010-001	95354	P-455

SECTION IX
VARIABLE FREQUENCY MODULE

9-1. DESCRIPTION

9-2. Refer to paragraphs 1-11, 1-12, 4-14, and 4-15 for a description of the module. Refer to paragraph 5-18 for adjustments. Refer to figure 9-2 for schematic diagram. Refer to figures 9-3, 9-4, and 9-5 for circuit board layouts.

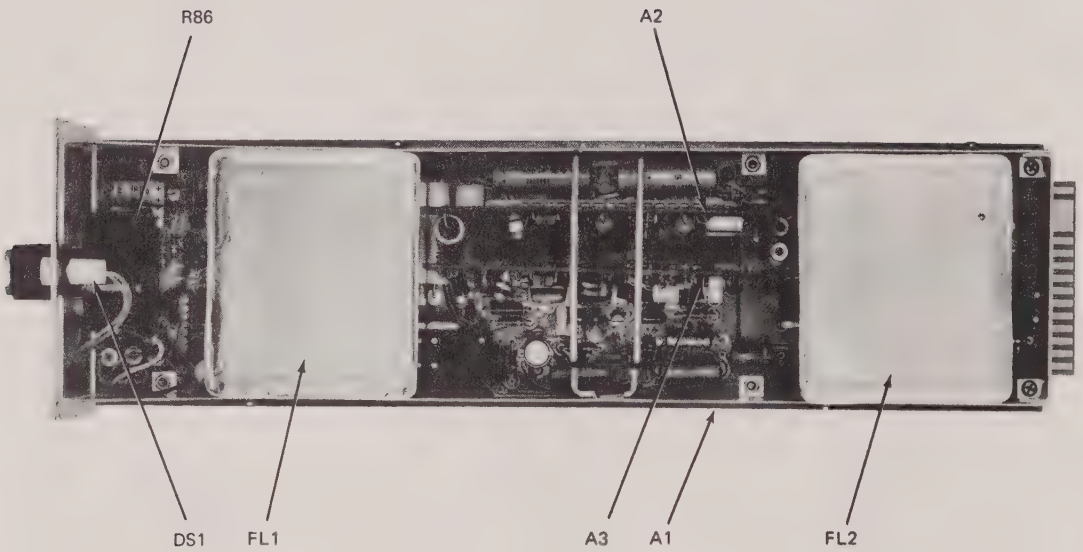
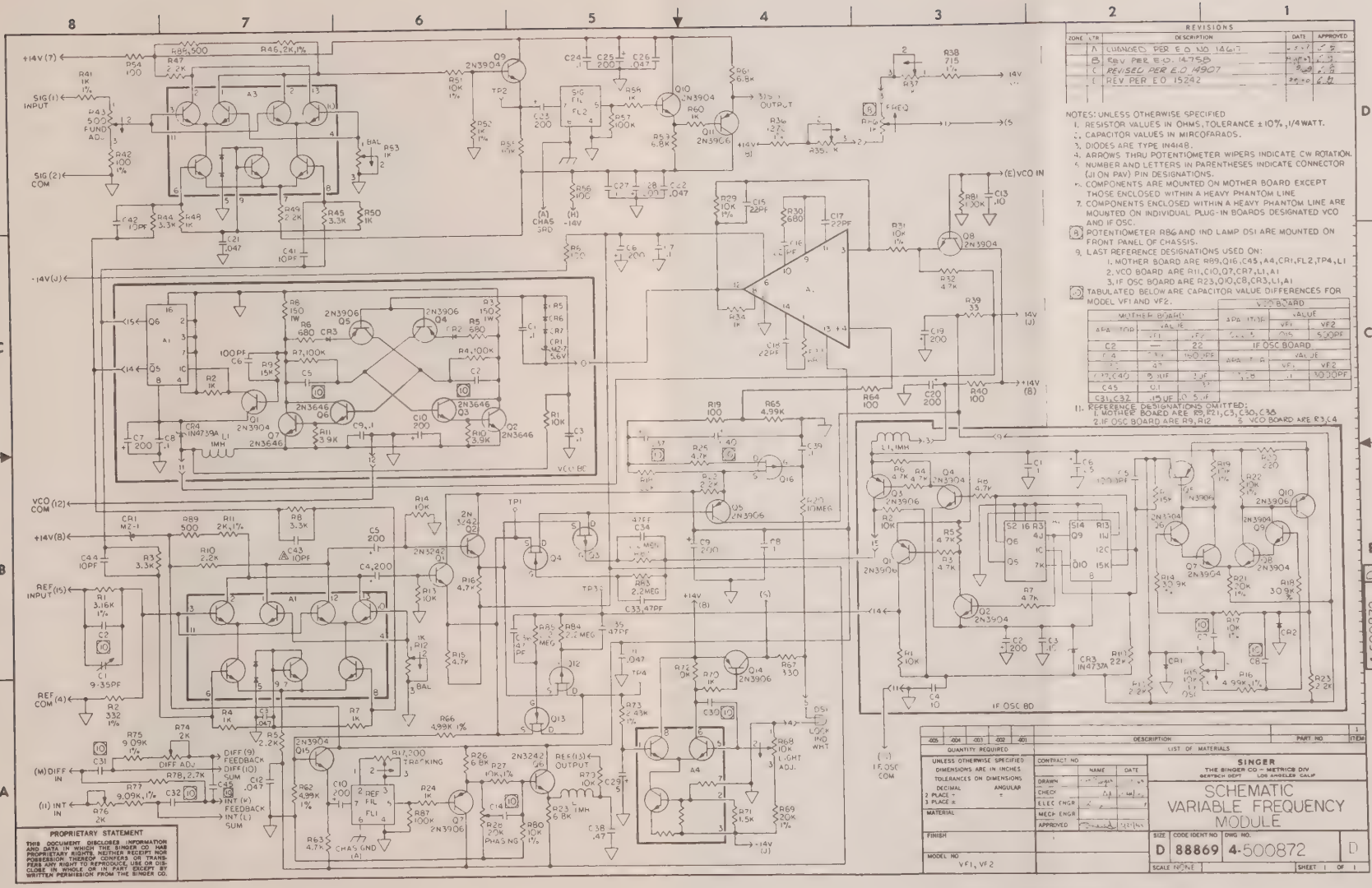


Figure 9-1. Variable Frequency Module VF-1, Top View


REVISIONS
ZONE LTR
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DATE
APPROVED
A CHANGED PER E.O. NO. 14617
B REV PER E.O. 14758
C REVISED PER E.O. 14907
D REV PER E.O. 15242
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES IN OHMS, TOLERANCE ±10%, 1/4 WATT.
2. CAPACITOR VALUES IN MICROFARADS.
3. DIODES ARE TYPE IN4148.
4. ARROWS THRU POTENTIOMETER WIPERS INDICATE CW ROTATION.
5. NUMBER AND LETTERS IN PARENTHESES INDICATE CONNECTOR (J1 ON PAV) PIN DESIGNATIONS.
6. COMPONENTS ARE MOUNTED ON MOTHER BOARD EXCEPT THOSE ENCLOSED WITHIN A HEAVY PHANTOM LINE
7. COMPONENTS ENCLOSED WITHIN A HEAVY PHANTOM LINE ARE MOUNTED ON INDIVIDUAL PLUG-IN BOARDS DESIGNATED VCO AND IF OSC.
8. POTENTIOMETER R86 AND IND LAMP DS1 ARE MOUNTED ON FRONT PANEL OF CHASSIS.
9. LAST REFERENCE DESIGNATIONS USED ON:
1. MOTHER BOARD ARE R89, Q16, C45, A4, CR1, FL2, TP4, L1
2. VCO BOARD ARE R11, C10, Q7, CR7, L1, A1
3. IF OSC BOARD ARE R23, Q10, C8, CR3, L1, A1
10. TABULATED BELOW ARE CAPACITOR VALUE DIFFERENCES FOR MODEL VF1 AND VF2.
MOTHER BOARD VALUE
VCO BOARD VALUE
IF OSC BOARD VALUE
11. REFERENCE DESIGNATIONS OMITTED:
1. MOTHER BOARD ARE P1, P21, C3, C30, C38
2. IF OSC BOARD ARE R9, R12
3. VCO BOARD ARE R3, C4
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LIST OF MATERIALS
QUANTITY REQUIRED
DESCRIPTION
PART NO
ITEM
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DIMENSIONS
DECIMAL ANGULAR
2 PLACE ± ±
3 PLACE ± ±
MATERIAL
FINISH
MODEL NO
VF1, VF2
CONTRACT NO
NAME DATE
DRAWN
CHECK
ELEC ENGR
MECH ENGR
APPROVED
SINGER
THE SINGER CO — METRICS DIV
BERGEN DEPT LOS ANGELES CALIF
SCHEMATIC
VARIABLE FREQUENCY
MODULE
SIZE D
CODE IDENT NO 88869
DWG NO. 4-500872
SCALE NONE
SHEET 1 OF 1
4-500872 D

Figure 9-2. Schematic Diagram, VF Module

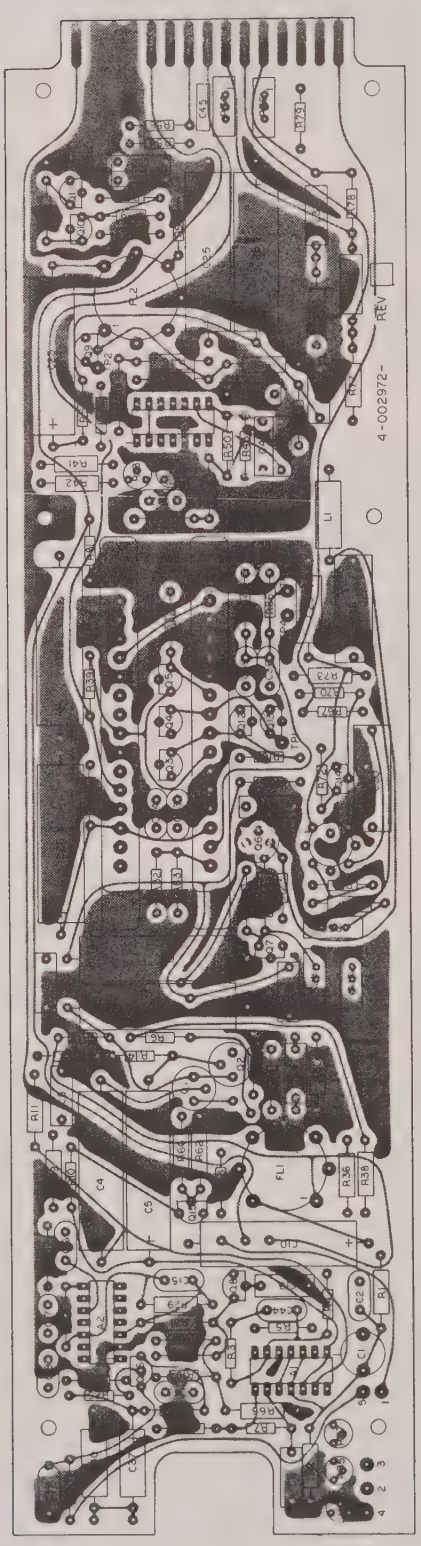

Figure 9-3. Location of Parts, Mother Board

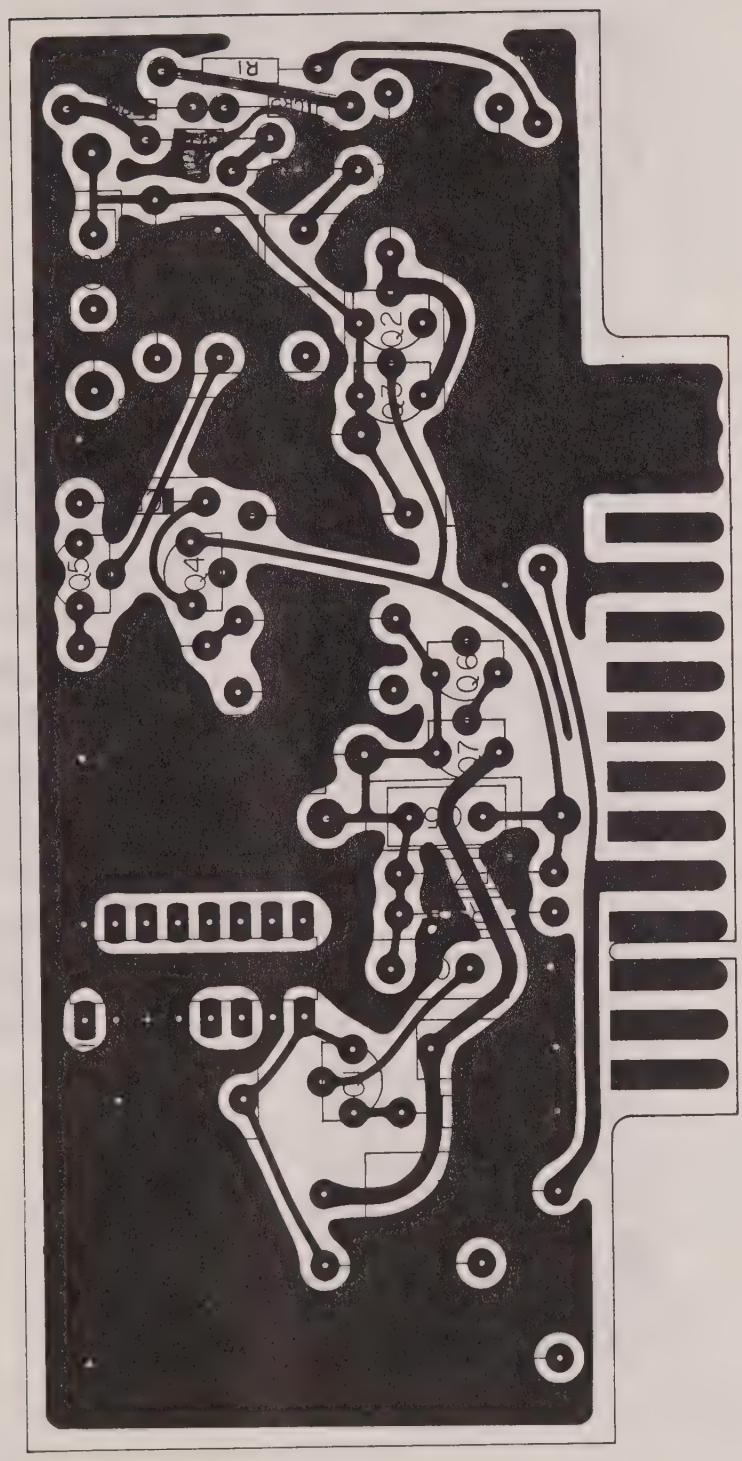

Figure 9-4. Location of Parts, VCO Board

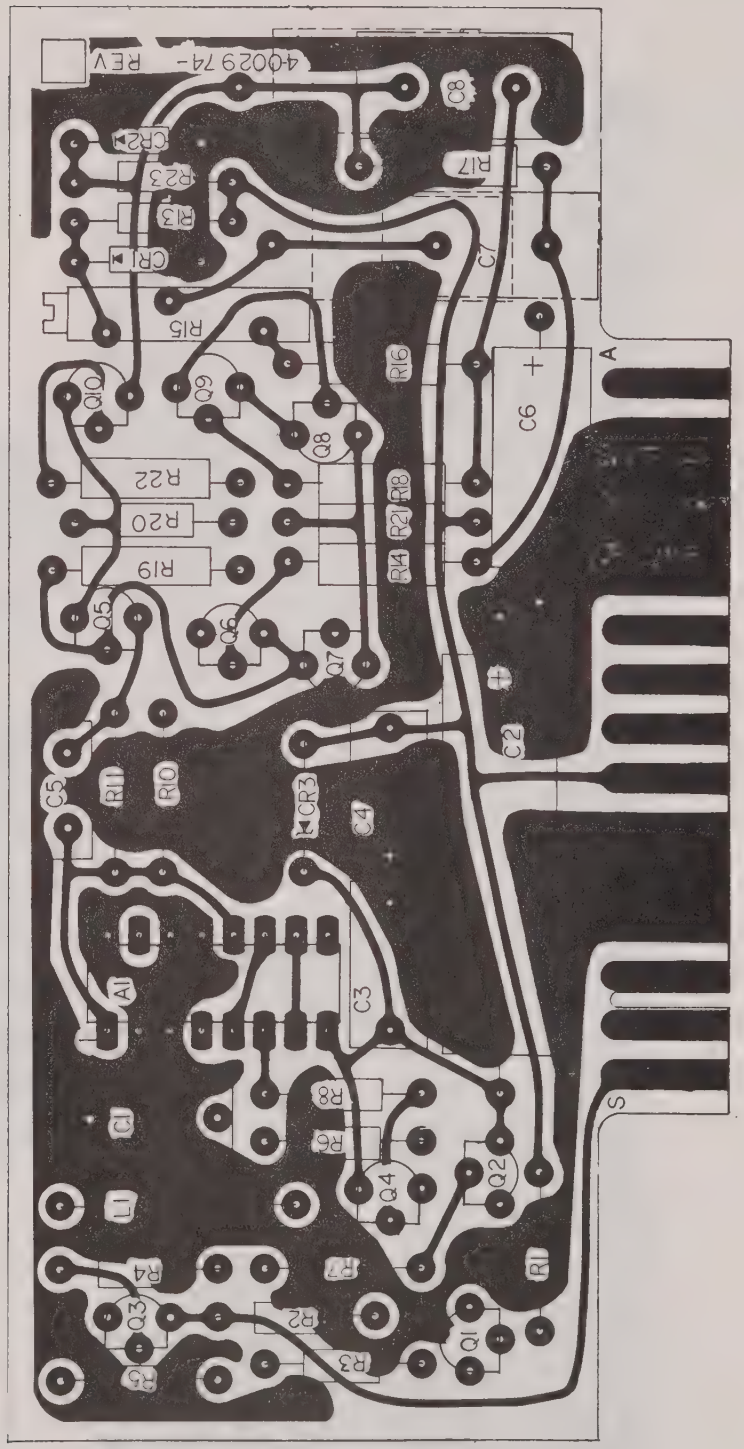

Figure 9-5. Location of Parts, IF Osc Board

PARTS LIST
VF-1/VF-2

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
A1	Mother Board Assembly	4-002972-001	–	-	1	-
		4-002972-002	–	–	–	1
A2	VCO Board Assembly	4-002973-001	–	–	1	
		4-002973-002	–	–		1
A3	IF Osc Board Assembly	4-002974-001	–	–	1	–
		4-002974-002	–	–	–	1
DS1	Light Indicator	1-925007-005	X0001	L - 10/20	1	1
FL1	Filter	1-402793-001		–	1	
		1-402793-002	–	–	–	1
FL2	Filter	1-402793-001	–	–	1	–
		1-402793-002	–	–	–	1
R86	Resistor, variable	1-945055-001	X0002	CLR4001-15 1000	1	1

MOTHER BOARD (See Figure 9-3)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
A1, A3	Integrated Circuit	1-926023-001	Signetics	NE510A	2	2
A2	Integrated Circuit	1-926006-001	RCA	CA 3030	1	1
A4	Integrated Circuit	1-926005-001	RCA	CA 3028A	1	1
C1	Capacitor, variable, 9-35pf	1-900031-003	Erie	538-011-9-35 PFD	1	1
C2	Capacitor, 22pf, 5%	1-900003-013	Electro-Motive	Type DM15	-	1
C3, 11, 12, 21, 22, 26	Capacitor, 0.47 uf	1-900001-009	Amperex	Type C280AE	6	6
C4, 5, 6, 9, 10, 19, 20, 23, 25, and 28	Capacitor, 200uf, 15V	1-900039-002	Gen. Inst.	984-141	10	10

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
C7, 8, 13, 24, 27, 39	Capacitor, .1uf	1-900001-013	Amperex	Type C280AE	6	6
C14	Capacitor, .039uf	1-900041-120	Elpac	HS5A393J	1	
		1-900041-151	Elpac	HS5A162J	–	1
C15, 16, 17, 18	Capacitor, 22pf	1-900003-013	Electro-Motive	Type DM15	4	4
C29	Capacitor, 5uf, 15V	1-900039-007	Gen. Inst.	984 - 9	1	1
C30, 38	Capacitor, .47uf	1-900001-021	Amperex	Type C280AE	2	–
C31, 32	Capacitor, .15uf	1-900041-127	Elpac	HS5A154J	2	
		1-900041-161	Elpac	HS5A502J	–	2
C33, 36	Capacitor, 47pf, 5%	1-900031-021	Electro-Motive	Type DM15	4	4
C37, 40	Capacitor, 90uf, 6V	1-900039-010	Gen. Inst.	984 - 27	2	–
	Capacitor, 3uf, 50V	1-900039-012	Gen. Inst.		–	2
C38	Capacitor, .47uf	1-900001-021	Amperex	Type C280AE	-	1
C41, 42, 43, 44	Capacitor, 10pf, 5%	1-900003-008	Electro-Motive	Type DM15	4	4
C45	Capacitor, metalized, plastic, 0.1uf	1-900001-013	Amperex	Type C280AE	1	–
	Capacitor, metallized, plastic, 0.0033uf	1-900001-036	Amperex	Type C280AE	–	1
CR1	Diode, Zener	1-913004-001	Motorola	Type MZ	1	1
J2, J3	Connector	1-910070-103	Viking	2VK15S2-2	2	2
L1	Choke, 1 M.H.	1-906007-003	Caddel Burns	670 - 3	1	1
Q1, 2, 6	Transistor, 2N3242	1-958033-002	RCA	2N3242A	3	3
Q3, 12, 16	Transistor, F.E.T.	1-958021-003	Motorola	2N5462-5	3	3
Q4, 13	Transistor, F.E.T.	1-958002-003	Motorola	MPF105 - 5	2	2
Q5, 7, 11, 14	Transistor, 2N3906	1-958000-002	Motorola	2N3906 - 5	4	4
Q8, 9, 10, 15	Transistor, 2N3904	1-958000-001	Motorola	2N3904 - 5	4	4
R1	Resistor, 3.16K	1-945016-241		Type RN60D	1	1
R2	Resistor, 332 ohms	1-945016-147		Type RN60D	1	1

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
R3, 8, 44, 45	Resistor, 3.3K	1-945000-043	Allen-Bradley	Type CB	4	4
R4, 7, 24, 34, 48, 50, 58, 60, and 70	Resistor, 1K	1-945000-037	Allen-Bradley	Type CB	9	9
R5, 10, 22, 47, and 49	Resistor, 2.2K	1-945000-041	Allen-Bradley	Type CB	5	5
R6, 19, 40, 54, 56, 64	Resistor, 100 ohms	1-945000-025	Allen-Bradley	Type CB	6	6
R11, 46	Resistor, 2K, 1%	1-945016-222	—	Type RN60D	2	2
R12, 35, 37, 53	Resistor, variable, 1K	1-945037-007	Beckman Helipot	62PR1K	4	4
R13, 14, 55, 72, and 79	Resistor, 10K, 10%, 1/4W	1-945000-049	Allen-Bradley	Type CB	5	5
R15, 16, 25, 32, and 63	Resistor, 4.7K	1-945000-045	Allen-Bradley	Type CB	5	5
R17	Resistor, variable, 200 ohms	1-945056-005	Bourns, Inc.	3257W1-201	1	1
R18	Resistor, 22K	1-945000-053	Allen-Bradley	Type CB	1	1
R20	Resistor, 10 megohms	1-945000-085	Allen-Bradley	Type CB	1	1
R27, 29, 31, 51, 80	Resistor, 10K, 1%	1-945016-289	—	Type RN60D	5	5
R28	Resistor, variable, 20K	1-945056-011	Bourns	3257W1-201	1	1
R30, 33	Resistor, 680 ohms	1-945000-035	Allen-Bradley	Type CB	2	2
R36	Resistor, 1270, 1%	1-945016-203	-	Type RN60D	1	1
R38	Resistor, 715, 1%	1-945016-179	—	Type RN60D	1	1
R39	Resistor, 33 ohms	1-945000-019	Allen-Bradley	Type CB	1	1

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
R41, 52	Resistor, 1K	1-945016-193	–	Type RN60D	2	2
R42	Resistor, 100 ohms, 1%	1-945016-097	–	Type RN60D	1	1
R43	Resistor, variable, 500 ohms	1-945037-006	Beckman - Helipot	62PR500	1	1
R57, 81, and 87	Resistor, 100K, 10%, 1/4W	1-945000-061	Allen-Bradley	Type CB	3	3
R62, 65 and 66	Resistor, 4.99K, 1%	1-945016-260	–	Type RN60D	3	3
R67	Resistor, 330 ohms	1-945000-031	Allen-Bradley	Type CB	1	1
R68	Resistor, variable, 10K	1-945056-010	Bourns	3257W1-103	1	1
R69	Resistor, 20K, 1%	1-945016-318	–	Type RN60D	1	1
R71	Resistor, 1.5K	1-945000-039	Allen-Bradley	Type CB	1	1
R73	Resistor, 2.43K, 1%	1-945016-230	–	Type RN60D	1	1
R74, 76	Resistor, 2K	1-945056-008	–	3257W1-202	2	2
R75, 77	Resistor, 9.09K	1-945016-289	–	Type RN60D	2	2
R78	Resistor, 2.7K	1-945000-042	Allen-Bradley	Type CB	1	1
R82, 83, 84, 85	Resistor, 2.2 megohms	1-945000-077	Allen-Bradley	Type CB	4	4
R88, 89	Resistor, 500 ohms	1-945066-002	Allen-Bradley	Type CB	2	2
XFL1, XFL2	Socket	1-950010-001	Methode	Type P-455	2	2

VCO BOARD (See Figure 9-4)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
A1	Integrated Circuit	1-926021-002	Signetics	SP332B	1	1
C1, C3, C8, C9	Capacitor, metal, plastic, .1uf	1-900001-013	Amperex	Type C280AE	4	4
C2, C5	Capacitor, plastic, .015uf	1-900041-115	Elpac, Inc.	HS5A153J	2	–
C4	Not Used					

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
C6	Capacitor, 100pf, 5%	1-900003-030	Electro-Motive	DM15		
C7, 10	Capacitor, electrolytic, 200uf, 15V	1-900039-002	Gen. Inst.	984 - 141	2	2
CR1	Diode, Zener	1-913004-007	Motorola	Type MZ	1	1
CR2	Diode	1-913007-001	G.E.	1N4148	1	1
CR3	Diode	1-913007-001	G.E.	1N4148	1	1
CR5	Diode	1-913007-001	G.E.	1N4148	1	1
CR6	Diode	1-913007-001	G.E.	1N4148	1	1
CR7	Diode	1-913007-001	G.E.	1N4148	1	1
CR4	Diode, Zener	1-913020-112	Motorola	1N4739A	1	1
L1	Choke, 1 MH	1-906007-003	Caddel Burns	670 - 3	1	1
Q1	Transistor, NPN	1-958000-001	Motorola	2N3904-5	1	1
Q2	Transistor, NPN	1-958034-001	Fairchild	2N3646	1	1
Q3	Transistor, NPN	1-958034-001	Fairchild	2N3646	1	1
Q4	Transistor, PNP	1-958000-002	Motorola	2N3906-5	1	1
Q5	Transistor, PNP	1-958000-002	Motorola	2N3906-5	1	1
Q6	Transistor, NPN	1-958034-001	Fairchild	2N3646	1	1
Q7	Transistor, NPN	1-958034-001	Fairchild	2N3646	1	1
R1	Resistor, comp, 10K, 1/4W, 10%	1-945000-049	Allen-Bradley	Type CB	1	1
R2	Resistor, comp, 1K, 1/4W, 10%	1-945000-037	Allen-Bradley	Type CB	1	1
R3, R8	Resistor, comp, 150 ohm, 1W, 10%	1-945002-027	Allen-Bradley	Type GB	2	2
R4, R7	Resistor, comp, 100K, 10%, 1/4W	1-945000-061	Allen-Bradley	Type CB	2	2
R5, R6	Resistor, 680 ohm, 1/4W, 10%	1-945000-035	Allen-Bradley	Type CB	2	2
R9	Resistor, comp, 15K, 1/4W, 10%	1-945000-051	Allen-Bradley	Type CB	1	1
R10, R11	Resistor, comp, 3.9K, 1/4W, 10%	1-945000-044	Allen-Bradley	Type CB	2	2

IF OSC BOARD (See Figure 9-5)

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
A1	Integrated Circuit	1-926021-002	Signetics	SP 322B	1	1
C1, 3, C4	Capacitor, metal, plastic, 0.1uf	1-900001-013	Amperex	Type C280AE	3	3
C2	Capacitor, electrolytic, 200uf, 15V	1-900039-002	General Inst. Corp.	984 - 141	1	1
C5	Capacitor, 3000pf, 5%	1-900003-056	Electro-Motive	DM15	1	1
C6	Capacitor, electrolytic, 25uf, 25V	1-900039-001	Gen. Inst.	984 - 118	1	1
C7, C8	Capacitor, plastic, 0.1uf	1-900041-125	Elpac, Inc.	HS5A104J	2	–
	Capacitor, 3000pf, 5%	1-900004-023	Electro-Motive	DM19	–	2
CR1, CR2	Diode	1-913007-001	G.E.	1N4148	2	2
CR3	Diode, Zener	1-913020-110	Motorola	1N4737A	1	1
L1	Choke, 1 MH	1-906007-003	Caddel Burns	670 - 3	1	1
Q1, Q3, 5, and 10	Transistor, PNP	1-958000-002	Motorola	2N3906 - 5	4	4
Q2, 4, 6, 7, 8 and 9	Transistor, NPN	1-958000-001	Motorola	2N3904 - 5	6	6
R1, R2	Resistor, comp, 15K, 1/4W, 10%	1-945000-049	Allen-Bradley	Type CB	2	2
R3 – R8	Resistor, comp, 4.7K, 1/4W, 10%	1-945000-045	Allen-Bradley	Type CB	6	6
R9	Not Used					
R10	Resistor, comp, 22K, 1/4W, 10%	1-945000-053	Allen-Bradley	Type CB	1	1
R11	Resistor, comp, 15K, 1/4W, 10%	1-945000-051	Allen-Bradley	Type CB	1	1
R12	Not Used					
R13, R23	Resistor, comp, 2.2K, 1/4W	1-945000-041	Allen-Bradley	Type CB	2	2
R14, R18	Resistor, film, 20K	1-945016-336	–	RN60D	2	2

REF DESIG	DESCRIPTION	SINGER REF NO.	MFG	MFG PART NO.	QTY	
					VF-1	VF-2
R15	Resistor, variable, 10K, 20T, WW	1-945039-010	Amphenol	3800P-103	1	1
R16	Resistor, film, 4.99K, 1%	1-945016-260	–	Type RN60D	1	1
R17, 19, 22	Resistor, film, 10K	1-945016-289	–	Type RN60D	3	3
R20	Resistor, comp, 220 ohms, 1/4W	1-945000-029	Allen-Bradley	Type CB	1	1
R21	Resistor, film, 20K	1-945016-318	–	Type RN60D	1	1

APPENDIX A
APPLICATION DATA

A-1. BRIDGE CIRCUIT APPLICATION.

A-2. In a bridge circuit, the phase angle voltmeter operates as a phase sensitive null detector with a high tolerance to a quadrature component. The PAV may be combined with any Gertsch RatioTran to form the AC bridge circuit shown in figure A-1.

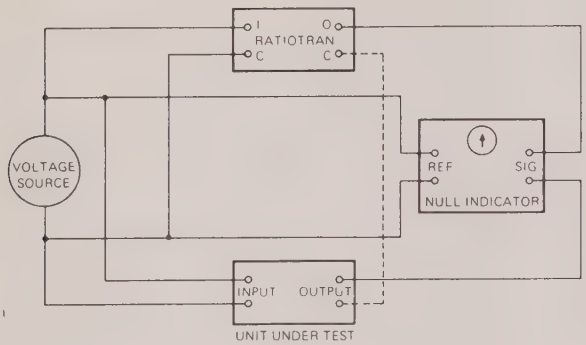

Figure A-1. AC Bridge Circuit

A-3. In this circuit, the PAV is set to 0 degree for detection of in-phase nulls. The RatioTran is adjusted until null is obtained. The in-phase, input-to-output voltage ratio of the unit under test may be read directly from the settings of the RatioTran.

The range control (VOLTS-RMS) of the PAV functions as a sensitivity control. If noise, harmonics, etc., obscure the null point, a higher range may be used. For more precise measurements, the lower ranges may be used.

A-4. The variable control of the PAV may be used for "go" "no-go" measurements. A typical procedure is as follows:

a. Obtain an exact null at a selected reference point (0 degree output of unit-under-test, output at center frequency or center position of unit-under-test).

b. Determine largest allowable deviation from this ratio setting. Offset the RatioTran by this amount.

c. Through the use of the variable control, set this off-null voltage to equal a full-scale meter reading.

d. Reset the RatioTran to the null point.

e. In subsequent readings, any off-scale reading indicates "no-go". Any on-scale reading may be read as a direct percentage error.

A-5. The quadrature component of a phase-shifted signal can overload the signal circuits of the PAV and obscure the in-phase null. Assume an output vector voltage of 100 volts rms and a phase shift of 0.01 degrees. The sine of 0.01

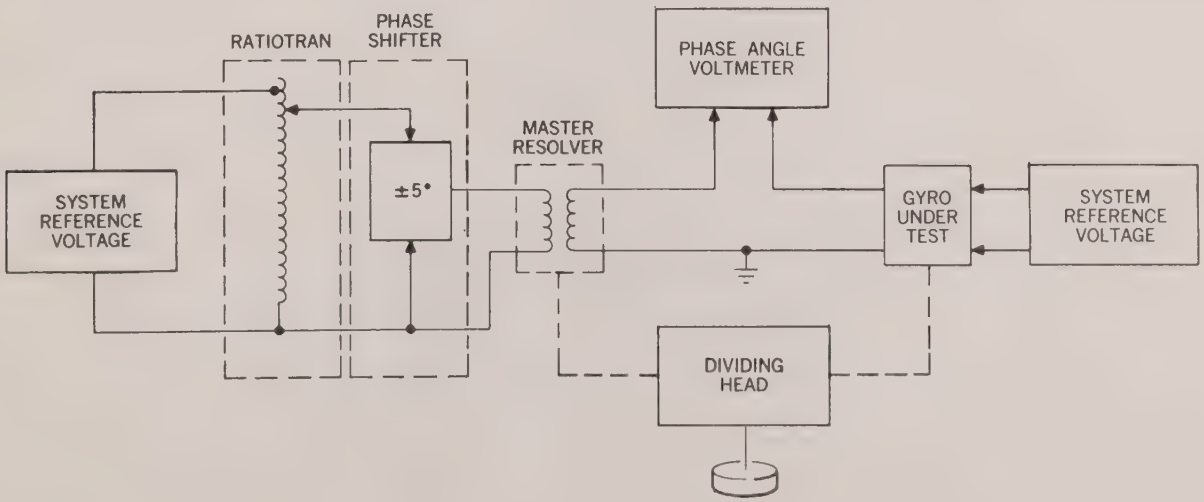

Figure A-2. Modified Bridge Circuit

degrees is 0.00017; 100 x 0.00017 results in a quadrature component of 17 millivolts. With the PAV operating in the 300uv or 1 millivolt range, this 17 millivolts represents an overload condition. The OVLD indicator would light although the meter would indicate null or near null. By switching to a higher range (less sensitivity), a more clearly defined null indication may be obtained.

A-6. Once null is obtained, a complete analysis of the output of the device under test may be made. The PAV may be operated in the 90 degree or FUND mode to measure quadrature voltage output. The PAV may be operated in the TOTAL mode to measure quadrature plus harmonic plus noise output.

A-7. MODIFIED BRIDGE CIRCUITS.

A-8. A typical modification of the bridge circuit is shown in figure A-2. In this circuit, the output of a gyro is compared against the output of a master resolver (null equals no error).

A-9. To compare the two units, some slight correction for phase shift and transformation ratio (RatioTran) are made. In this application the PAV is set to an angle equal to the phase shift through the master resolver.

A-10. Another modified bridge circuit is shown in figure A-3. This circuit is used to measure the functional accuracy of a computational resolver.

A-11. Functional accuracy is a measure of the accuracy with which a computational resolver computes a trigonometric equation. This accuracy is generally expressed as a percentage of the output at the point of maximum coupling. The output of a .1% computational resolver is maximum at 90 degrees for the sine function. The accuracy is therefore .001 times the voltage (E_S MAX) at 90 degrees ($\sin \theta = 90^o$).

A-12. A dividing head is the precision angular positioning device used to mechanically rotate a unit under test. A resolver standard produces a $\sin \theta$ reference voltage to measure the computed output of the unit under test. All components may be tested at 5 degree increments throughout the 0 to 360 degree range.

A-13. The decade capacitor and the 1K resistor are used to compensate for any phase shift through the unit under test. These components are used to shift the phase of the reference input to the phase angle voltmeter and the resolver standard. The RatioTran by the same process compensates for any variation in transformation ratio through the unit under test.

A-14. SYNCHROS AND RESOLVERS

A-15. Most angular accuracy tests of synchros and resolvers use a bridge circuit which requires a phase sensitive null indicator, equipped with a calibrated phase shifter. The variable control is particularly useful when checking the output at 5 degree increments throughout the 360 degree range of the component. Null voltage readings may be made by switching the PAV to the fundamental or total modes. Transformation ratio may be determined with a RatioTran as shown in figure A-1. The calibrated phase shifter provides a readout of phase shift (θ) of the unit-under-test.

A-16. TRANSFER FUNCTION TESTS.

A-17. A typical transfer function test set-up is shown in Figure A-4.

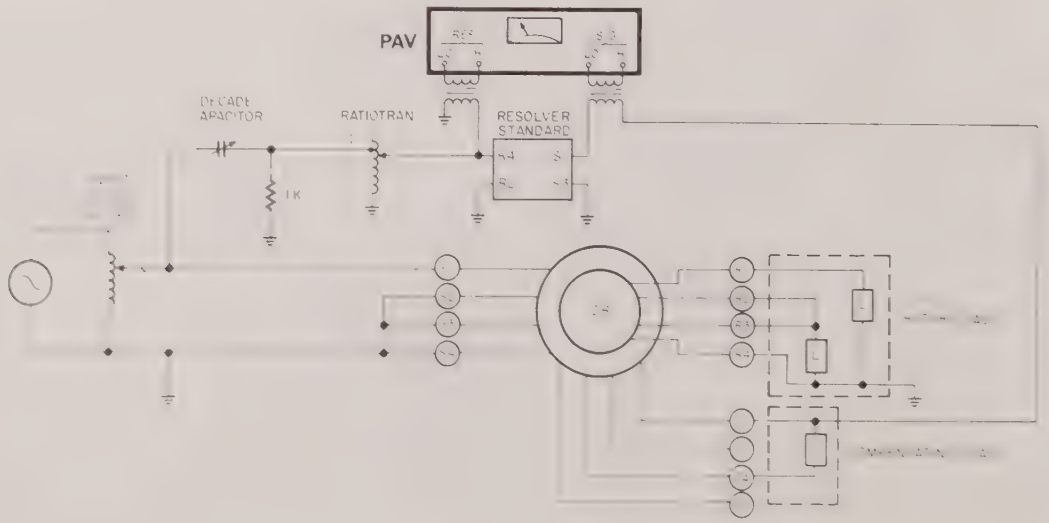

Figure A-3. Functional Accuracy Test

In this application, the PAV measures absolute amplitude at a selected frequency and phase angle (instead of detecting nulls). For point-by-point frequency response measurements, a variable frequency module is required. The RatioTran provides very precise changes in input level.

A-18. A specific frequency and amplitude level are used to establish nominal gain and phase shift through the device under test. Phase shift may be measured as outlined in paragraph 3-1 and gain may be measured in the phase sensitive or fundamental modes. The nominal gain may then be set for full scale indication as outlined in paragraph 3-3. Subsequent indications may then be read as a direct percentage figure.

A-19. This same technique may be used for transformer tests (figure A-5), filter analysis, transducer tests (figure A-6), etc.

A-20. SERVO SYSTEM TESTING.

A-21. One important test of a system is to measure the exact output angle of a synchro or resolver installed in that system. In the Gertsch method, the system is set to the required position and a decade bridge and null indicator are used to measure the angle. The decade bridge is adjusted to obtain an exact null on the null indicator and the exact angular position of the synchro or resolver may be read from the dials of the bridge; The PAV may also be used to measure the approximate phase shift angle of the system.

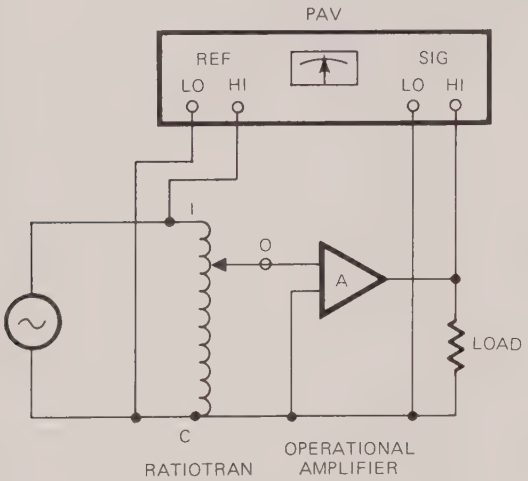

Figure A-4. Operational Amplifier Test

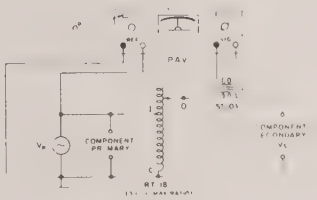

Figure A-5. Transformation Ratio Test

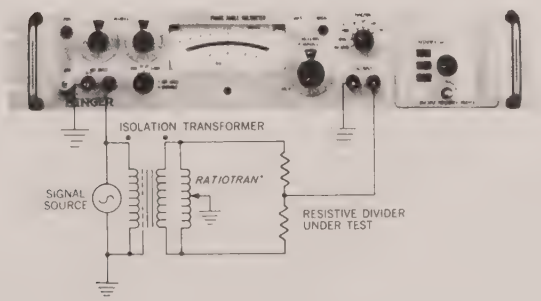

Figure A-6. Transducer Tests

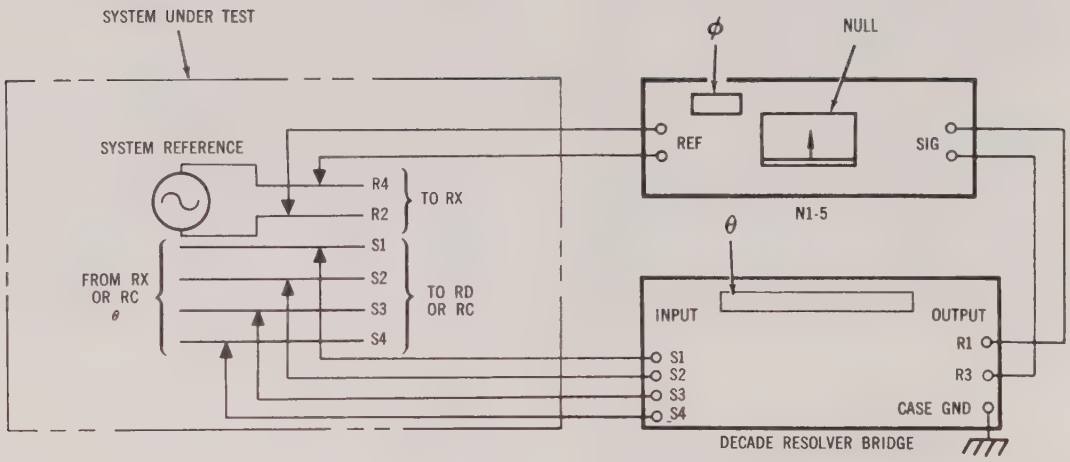

Figure A-7. Resolver System

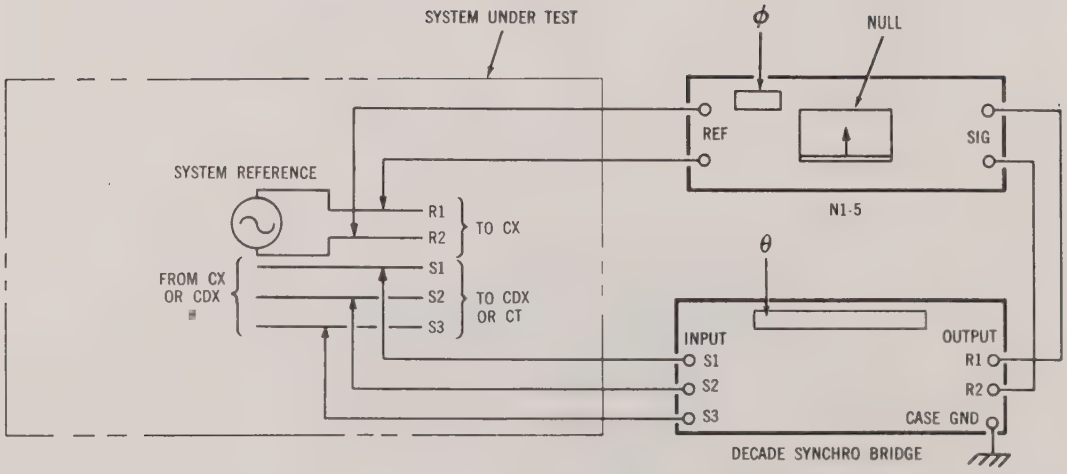

Figure A-8. Synchro System

ADDENDUM
For
Manual No. 1-500783-152 (Rev. B)
Model PAV-4 Series

ERRATA

Perform the following changes to the above manual.

Page 9-12: IF OSC BOARD
CR3, SINGER REF NO., Was: 1-913020-110 Is: 1-913004-010

Page 9-10: VCO BOARD (See Figure 9-4).
A1, MFG PART NO., Was: SP332B Is: SP322B

Page 3-2: Paragraph 3.8
Was: VDC OUTPUT Is: 1 VDC OUTPUT

Change paragraph numbers 3-9, 3-10, 3-11 to 3-10, 3-11, 3-12
Add: 3-9 DC OUTPUT
To provide analog voltage proportional to meter reading; i.e., 1 V on 10's scales, 0.3 on 3's scales for full-scale deflections.

Page 3-5/3-6:
Change paragraph numbers 3-12, 3-13, 3-14, 3-15 to 3-13, 3-14, 3-15, 3-16 respectively.

Page 3-4: TABLE 3-1. CONTROLS AND INDICATORS (CONT)
SIGNAL INPUT (rear), Binding Posts, (Black-LO), Was: (J9) Is: (J7)

Page 4-9/4-10: Figure 4-10. Schematic Diagram, PAV-4C
Add: Change C20, from a variable capacitor, 9-35 pF, to a fixed capacitor, 200 pF

Page 6-32: DETECTOR CIRCUIT BOARD A8 (see Figure 6-9)
C20, PAV-4C only, Add: SINGER REF NO. 1-900003-037 MFG CODE 73136

Page 6-41: ISOLATION INPUT CIRCUIT BOARDS A10, A12 (see Figure 6-11)
C9 (on A10, PAV-4C only), Add: SINGER REF NO. 1-900003-045

Approved	Revision	Initials
1/3/73		

FORM NO. 160 1M 3-70 D-H

ADDENDUM

Page 1-2: TABLE 1-1. SPECIFICATIONS

Accuracy, Voltage, total mode; Was: 2% (50 Hz to 20 KHz) of f. s.
3% (30 Hz to 100 KHz) of f. s.
5% (100 KHz to 300 KHz) of f. s.

Is: 3% (50 Hz to 20 KHz) of f. s.
4% (30 Hz to 100 KHz) of f. s.
6% (100 KHz to 300 KHz) of f. s.
from 15°C to 35°C

Noise: Add a third column with the following information:

	PAV-4/VF-2
Total Mode:	40 μV (max.)
Fund. Mode:	30 μV (max.)

MODEL VF-1, VF-2

Phase Accuracy, Was: (1.0 + 0.01f KHz) degrees
Is: (2.0 + 0.01f KHz) degrees (15 to 35°C)

Page 1-2. Table 1-1. Specifications

Model SF-1, MF-1 :
Phase Accuracy; WAS : 0.5 deg. over entire freq. range
IS : 1.5 deg. over entire freq. range

RUNNING CHANGES

Perform the following changes to the manual up to the serial number effectivity of your instrument.

Effective date: April 12, 1973 (Effective serial number: 771 and above)

Page 4-6: Figure 4-7. Schematic Diagram, PAV-4B, (S/N 401 and up)
Diodes CR1 thru CR4, Isolation Inverter Boards A11 and A13,
Was: 1N914 Is: 1N4148

Page 6-43: ISOLATION INVERTER CIRCUIT BOARD A11, A13

CR1-CR4, Was:	Diode	1-913000-001	01295	1N914	
Is:	Diode	1-913007-001	04713	1N4148	

Effective date: November 28, 1973 (Effective serial numbers: 4A-821 and above)
4B-771 and above)

Page 4-5 and 4-6: Figures 4-6 and 4-7, PAV-4A and 4B
Power Supply and Voltage Regulator, A5
R13, R14, Was: 4.7K Is: 820
Add: C11, 120 uF, in parallel with CR3 with curved side to R14
C12, 120 uF, in parallel with CR2 with curved side to R13

Page 6-22: POWER SUPPLY CIRCUIT BOARD

Below C10, add: C11	Capacitor, elect, 120 uF, 15V	1-900115-001	12954	D120GSD15M	A B
C12	Capacitor, elect, 120 uF, 15V	1-900115-001	12954	D120GSD15M	A B

Page 6-23: POWER SUPPLY CIRCUIT BOARD

R13, Was:	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB		A B
Is:	Resistor, comp, 820 ohm, ±10%, 1/4W	1-945000-036	01121	Type CB		A B
R14, Was:	Resistor, comp, 4.7K ±10%, 1/4W	1-945000-045	01121	Type CB		A B
Is:	Resistor, comp, 820 ohm, ±10%, 1/4W	1-945000-036	01121	Type CB		A B

Effective serial number: Serial numbers suffixed with 04052 and above.
Page 4-5: Figure 4-6. Schematic Diagram, PAV-4A (S/N 401 and up)
A5C3 and A5C4, Was: 680 pF Is: 0.02 μF
Page 4-6: Figure 4-5. Schematic Diagram, PAV-4B, (S/N 401 and up)
A5C3 and A5C4, Was: 680 pF Is: 0.02 μF
Page 6-22: POWER SUPPLY CIRCUIT BOARD

APPROVED REVISED

RUNNING CHANGES (Continued)

C3 and C4,

Was:	Capacitor, mica, 680 pF, ±5%, 300 Vdcw	1-900003-052	72136	DM15F681J	A	B
Is:	Capacitor, ceramic, 0.02 μF, ±20%, 100 Vdc	1-900077-003	56289	TG-S20	A	B

REVISED

APPROVED

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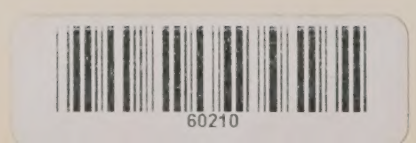
SINGER INSTRUMENTATION LOS ANGELES, CALIF.	TITLE ADDENDUM Model PAV-4 Series	DWG NO. I- 500783-152(B) SHEET 2.2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